PROCEEDINGS

OF THE TWENTY-SECOND ~~ANNUAL~~ + 23 ANNUAL

WESTERN FOREST INSECT WORK CONFERENCE

Glenwood Springs, Colorado

March 1-4, 1971

EDMONTON, ALBERTA

MARCH 6-9, 1972

<u>Not for Publication</u>

(For information of Conference Members only)

Prepared at

Rocky Mountain Forest and Range Experiment Station
U.S.D.A. - Forest Service
Fort Collins, Colorado

Rocky Mountain Forest and
Range Experiment Station
240 W. Prospect
Fort Collins, Colorado 80521

November 29, 1974

Dear WFIWC Member:

The enclosed 1971-72 proceedings have been mistakenly printed with the title page of the 1971 conference on the cover. The cover should indicate that this volume contains the proceedings of both the Twenty-second and Twenty-third Conferences as listed on the first page inside the cover. Rather than ask the printer to replace the cover with a properly titled cover, and incur further delays, I decided to distribute the enclosed copy. I regret this error on my part and will notify Gene Amman so he can insert the correction in the minutes of the 1975 conference.

Sincerely,

John M. Schmid

JOHN M. SCHMID
Secretary-Treasurer

PROCEEDINGS

OF THE TWENTY-SECOND AND TWENTY-THIRD ANNUAL

WESTERN FOREST INSECT WORK CONFERENCES

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Front Row, L to R. D. Crosby, L. N. Kline, R. C. Bechwith, F. M. Yasinski, J. A. E. Knopf, R. F. Schmitz, R. W. Gustafson, G. C. Trostel, H. W. Flake
Middle Row, L to R. J. W. Dale, J. W. E. Harris, D. C. Schmiege, R. L. Lyon, R. E. Pillmore, W. M. Ciesla, L. E. Drake, L. W. Sippell
Back Row, L to R. J. G. Laut, J. E. Coster, E. H. Lampi, J. A. Schenk, W. F. McCambridge, T. W. Koerber, F. P. Weber, B. N. Roettgering, J. L. Rauschenberger

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Back Row, L to R. S. Mata, J. Mitchell, D. McComb, D. Dyer, J. Hard, B. Stevens, B. Coulson, D. Cahill

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D. Parker, B. Ives, L. Stipe, S. L. Wood, R. Hall
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B. Heller, D. MacDonald, H. Thompson, M. Houseweart, J. Wentz

Front Row, L to R. W. Cole, M. McFadden, F. Stephen, C. Dudley,
A. Berryman, M. Birch, D. Wood
Back Row, L to R. B. Waters, R. Stark, D. Hester, B. Bailey

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PROGRAM

TWENTY-SECOND ANNUAL WESTERN FOREST INSECT WORK CONFERENCE
HOTEL COLORADO, GLENWOOD SPRINGS, COLORADO
March 1-4, 1971

<u>Monday, March 1</u>

8:00 a.m. - 8:00 p.m.	Registration Lobby displays: (1) Spruce beetle outbreaks of 1949-1952. (2) Mountain pine beetle in ponderosa pine--maximum controllable size (?) and maximum eventual destruction (?). (3) The White River in Kodachrome.
9:00 a.m. - 4:00 p.m.	<u>Achorutes socialis</u> competition
4:30 p.m. - 5:30 p.m.	Executive Committee meeting.
6:00 p.m. - 9:00 p.m.	Introductory mixer and buffet. Competition awards and ski film.

<u>Tuesday, March 2</u>

8:00 a.m. - 5:00 p.m.	Registration
8:00 a.m. - 9:00 a.m. Colorado Room	Initial business meeting
9:00 a.m. - 10:00 a.m. Colorado Room	Multiple Use Problems Unique to the White River National Forest.--Bruce Murdoch, U.S. Forest Service, Glenwood Springs, Colo.
10:00 a.m. - 10:30 a.m.	Coffee
10:30 a.m. - 11:30 a.m.	Forest Entomology in New Zealand.--Fred B. Knight, University of Michigan, Ann Arbor, Mich.
11:30 a.m. - 1:00 p.m.	Lunch
1:00 p.m. - 2:45 p.m. Red Mountain Room	<u>Workshop:</u> How Effective are Bark Beetle Chemical Control Programs and How Can They be Improved?--Dwight Hester, U.S. Forest Service, Denver, Colo.

1:00 p.m. - 2:45 p.m.	Panel: Attraction of Defoliators: Status and Potential. Moderator: Mel McKnight, Rocky Mt. For. and Range Exp. Stn., Bottineau, N. D.
	Basic Principles.--Harry Shorey, Univ. of California, Riverside, Calif.
	The Gypsy Moth.--Tom McIntyre, USDA, ARS, Hyattsville, Md.
	Choristoneura sp. and Forest Tent Caterpillar.--C. J. Sanders, Canadian Forestry Service, Sault Ste. Marie, Ontario.
	Western Forest Defoliators.--Gary Daterman, Pacific Northwest For. and Range Exp. Stn., Corvallis, Oreg.
2:45 p.m. - 3:00 p.m.	Coffee
3:00 p.m. - 5:00 p.m. Colorado Room	Panel: Regional and National Views on Needs and Justifications for Insect Control as Seen From: Industry, Government, Education, Conservation. Moderator: Royce Cox, Potlatch Forests, Inc., Lewiston, Idaho.
	E. C. Connors, Colorado Open Spaces Coordinating Council, Inc., Denver, Colo.
	Amel Landgraf, U.S. Forest Service, Div. Forest Pest Control, Washington, D.C.
	Oscar Schmunk, Colorado State Forest Service, Fort Collins, Colo.
	Ron Stark, University of Idaho, Moscow, Idaho.
	D. R. Macdonald, Canadian Forestry Service, Fredericton, N.B.

Wednesday, March 3

8:00 a.m. - 10:00 a.m. Colorado Room	Panel: Bark Beetle Attractant Tests of 1970. Moderator: Galen Trostle, U.S. Forest Service, Ogden, Utah. Southern Pine Beetle in Texas.--J. E. Coster, Texas A&M, Overton, Texas Western Pine Beetle in California.--D. L. Wood, University of California, Berkeley, Calif. Douglas-fir Beetle in Idaho.--J. A. E. Knopf, U.S. Forest Service, Boise, Idaho. Mountain Pine Beetle in Idaho.--G. B. Pitman, Boyce Thompson Inst., Grass Valley, Calif. Mountain Pine Beetle in Utah.--Walt Cole, Intermt. For. and Range Exp. Stn., Ogden, Utah.
8:00 a.m. - 10:00 a.m. Red Mountain Room	Workshop: Computers in Surveys and Research. Planning Surveys, Time Sharing, Data Gathering, Limitations of New Desk Models. Moderator: Harold Flake, U.S. Forest Service, Albuquerque, N. Mex.
10:00 a.m. - 10:20 a.m.	Coffee
10:20 a.m. - 12 noon Colorado Room	Panel: Status of Remote Sensing in Forest Entomology. Moderator: Bob Heller, Pacific Southwest For. and Range Exp. Stn., Berkeley, Calif. Sampling Mountain Pine Beetle-Damaged Lodgepole Pine with 35 mm. Aerial Photography.--Bill Klein, U.S. Forest Service, Ogden, Utah. Thermal and Multispectral Studies in Connection With the Black Hills Beetle.--Phil Weber, Pacific Southwest For. and Range Exp. Stn., Berkeley, Calif. Aerial Surveys and Photography in Colorado, Wyoming and South Dakota.--Bill Bailey, U.S. Forest Service, Denver, Colo.

Mountain Pine Beetle Survey in Lodgepole Pine in Washington.--John Wear, U.S. Forest Service, Portland, Oregon.

Status of Remote Sensing Surveys in the South and Plans for Montana and Northern Idaho.--Bill Ciesla, U.S. Forest Service, Missoula, Mont.

Aerial Photography Studies at Berkeley and Related NASA Programs.--Bob Heller, Pacific Southwest For. and Range Exp. Stn., Berkeley, Calif.

10:20 a.m. - 12 noon
Red Mountain Room

Panel: Graduate Student Problem Selection Process. Is There a Need to Establish Regional or National Problem Priorities? Moderator: Ron Stark, University of Idaho, Moscow, Idaho.

Open dialogue

12 noon - 1:20 p.m.

Lunch

1:20 p.m. - 3:00 p.m.

Potpourri
Moderator: Dick Washburn, Intermt. For. and Range Exp. Stn., Fort Collins, Colo.

1. New Insect-Host Relationships.

   Pinyon Needle Scale in California.--Bruce Roettgering, U.S. Forest Service, San Francisco, Calif.

   A Pine Looper in Ponderosa Pine.--Jed Dewey, U.S. Forest Service, Missoula, Mont.

2. Impact of Shelterbelt Insects in Canada and United States.

   Canada.--Bill Ives, Canadian Forestry Service, Edmonton, Alberta

   United States.--John Stein, Rocky Mt. For. and Range Exp. Stn., Bottineau, N. D.

3. Park Service Insect Control Problems Due to Chemical Restrictions

   Canadian National and Provincial Parks.--Les Safranyik, Canadian Forestry Service, Edmonton, Alberta.

   U.S. National Parks.--Es Lampi, National Park Service, Santa Fe, New Mex.

4. Recent Developments in Bark Beetle Taxonomy.--Steve Wood, Brigham Young University, Provo, Utah.

3:00 p.m. - 3:20 p.m. — Coffee

3:20 p.m. - 5:00 p.m.
Colorado Room

Panel: The Use of Insect Hormones and Their Analogs in the Study and Control of Forest Insects
Moderator: John Borden, Simon Fraser University, Burnaby, B.C.

The Present Status of the Development of Insect Hormones and Analogs for Insect Control.--G. B. Staal, Zoecon Corp., Palo Alto, Calif.

The Role of Hormones in the Reproductive Physiology of Bark Beetles.--T. S. Sahota, Canadian Department Fisheries and Forestry, Victoria, B.C.

The Effect of Some Synthetic Juvenile Hormone Analogs on the Western Spruce Budworm, *Choristoneura occidentalis*.--C. E. Richmond, Pacific Southwest For. and Range Exp. Stn., Berkeley, Calif.

Summary of the Known Effects of 10-11 Epoxyfarnesenic Acid Ethyl Ester on *Ips paraconfusus* and *Trypodendron lineatum*.--John Borden, Simon Fraser University, Burnaby, B.C.

3:20 p.m. - 5:00 p.m. Aspen Room	Workshop: Tree Physiology and Insect Survival. Moderator: Les Safranyik, Canadian Forestry Service, Edmonton, Alberta.

Thursday, March 4

8:15 a.m. - 9:45 a.m. Red Mountain Room	Workshop: Insect Problems of Shade Trees and Ornamentals. Moderator: Wayne Brewer, Colorado State University, Fort Collins, Colo.
8:15 a.m. - 9:45 a.m. Aspen Room	Workshop: Bioclimatic Risk Classification for Defoliators. Moderator: Roy Shepherd, Canadian Department Fisheries and Forestry, Victoria, B.C.
8:15 a.m. - 9:45 a.m. Colorado Room	Workshop: Complicated Control Decisions. Moderator: Paul Buffam, U.S. Forest Service, Albuquerque, New Mex.
9:45 a.m. - 10:05 a.m.	Coffee
10:05 a.m. - 12 noon Colorado Room	Panel: How Should Control, Research and College Curricula be Redirected in Light of Current Concern Over Ecology and Pollution? Moderator: Alan Berryman, Washington State University, Pullman, Wash. Don Dahlsten, University of California, Berkeley, Calif. G. C. Trostle, U.S. Forest Service, Portland Oregon. Bill Hantsbarger, Colorado State University, Fort Collins, Colo. Don Schmiege, Pacific Southwest For. and Range Exp. Stn., Berkeley, Calif. Bob Stevens, Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.
12 noon - 1:30 p.m.	Lunch

1:30 p.m. - 3:00 p.m. Red Mountain Room	Workshop: Economic and Social Impact of Insect Outbreaks on Forests and Forest Use. Moderator: Ross Macdonald, Canadian Forestry Service, Victoria, B.C.
1:30 p.m. - 3:00 p.m. Colorado Room	Workshop: Techniques in Use to Predict Trends of Forest Insects and Needs for Control. Moderator: Bill McCambridge, Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.
1:30 p.m. - 3:00 p.m. Aspen Room	Workshop: Problems Inherent to Exotic Insect Outbreaks. Moderator: Thelma Finlayson, Simon Fraser University, Burnaby, B.C.
3:00 p.m. - 4:00 p.m.	Coffee
4:00 p.m. - 5:00 p.m. Colorado Room	Final business meeting.

MINUTES OF EXECUTIVE COMMITTEE MEETING
March 1, 1971

The meeting opened at 8:45 p.m. with Chairman Dave Wood presiding. The others present were: Past Chairman Dave Dyer; Secretary-Treasurer Tom Koerber; Program Chairman Bill McCambridge; Councilors Walt Cole, Don Dahlsten, and Les Safranyik.

Business:

A nominating committee consisting of Jerry Knopf, Roy Shepherd, and Paul Buffam was appointed to select a candidate for the office of councilor, to be elected at the final business meeting. The committee strongly suggested that the new councilor be from the Pacific Northwest area to maintain representation from that area on the executive committee.

Plans for the 1972 and 1973 meetings were discussed. After some discussion, Les Safranyik was appointed program chairman for the 1972 meeting to be held in Edmonton, Alberta.

Offers to provide a meeting site for the 1973 meeting in Tucson, Arizona, and in Ogden, Utah were considered. The executive committee decided to recommend the Arizona-New Mexico area to the membership with Tucson and Santa Fe as possible meeting sites.

Chairman Dave Wood mentioned that a request by a commercial concern asking permission to display a product at the meeting had been turned down. It has been the policy of the Work Conference to discourage commercial exhibits at the meeting. Salesmen should confine their efforts to individual contacts with prospective customers. The executive committee agreed with Dave Wood on this policy.

Bill McCambridge reported for the committee on current research. He asked that more specific information on titles of study plans or projects under way currently be obtained.

There being no further business, the meeting adjourned at 10:06 p.m.

MINUTES OF THE INITIAL BUSINESS MEETING
March 2, 1971

The meeting was opened by Chairman Dave Wood at 9:20 a.m. The minutes of the 1970 meeting were read by Secretary Tom Koerber.

Chairman Wood called for reports of the standing committees:

Committee on Current Research:

Bill McCambridge discussed the project and asked that specific study titles be provided, so more detail would be available on the roster.

Common Names Committee:

Dave McComb reported no new common names had been approved. The committee had declined to comment on the conflict in scientific name of the spruce beetle (*Dendroctonus rufipennis* = *obesus*). He presented the list of common names to be used in the revision of "Insect Enemies of Western Forests," being prepared by Bob Furniss. The members are invited to comment on the names.

Ethical Practices Committee:

Chairman Russ Mitchell was unable to attend but sent the accouterments of his office with a letter of apology and recommended Gary Daterman to serve in his place. Daterman was appointed forthwith.

The minutes of the Executive Committee were read.

Meeting sites for future meetings were discussed. Chairman Wood confirmed the appointment of Les Safranyik as program chairman for the 1972 meeting at Edmonton, Alberta.

Paul Buffam reported on preliminary work on selecting a site for the 1973 meeting. The relative merits of Santa Fe and Tucson as meeting sites were considered. Jerry Knopf extended an invitation to meet in the Intermountain Region in 1974.

The treasurer's report was presented:

The balance in the treasury prior to the 1970 meeting was $581.90. Receipts at the meeting were $1,296.25, and expenses were $1,609.01 for a loss of $312.76, leaving a balance of $269.14. Obviously, we cannot afford to lose $300 again, so this meeting was budgeted to make a profit. On the basis of an expected attendance of 120, receipts are expected to be approximately $800 and expenses about $550.

At the 1969 meeting, a rule was passed stating that persons who had not paid a registration fee for 2 years would be dropped from the mailing list, but names would be retained on the mailing list for an additional 2-year period on payment of a $5 fee. It was pointed out that the system would go into effect this year, with persons who registered at the 1969 meeting but not at the 1970 or 1971 meetings being given the choice of paying the $5 fee or being dropped. The members present raised no objections, and the treasurer was directed to put the system into action.

Awards for the Achorutes socialis ski race were presented:

Bill McCambridge took first place with a time of 1-9.2; Galen Trostle was second at 1-10.5; and Oscar Schmunk was third at 1-11.2. Jed Dewey was last at 1-47.5 and was awarded a magnificent fur-lined crock containing a fur-covered egg.

Program Chairman Bill McCambridge announced changes in meeting rooms and panel moderators.

The meeting adjourned at 9:58 a.m.

FOREST ENTOMOLOGY IN NEW ZEALAND

Fred B. Knight, University of Michigan, Ann Arbor, Michigan

During my year (1970) in New Zealand, I had a splendid opportunity to look at Forest Insect problems in a young developing country. I had often heard that insects and diseases were no problem, yet nurseries were being treated on a regular basis to control grubs and piles of lumber were fumigated throughout the summer shipping seasons of 1969-70. A very brief study of past history of insect activity in New Zealand showed that the kinds of problems and their number is very much in line with similar sized areas in other parts of the world.

The indigenous forested area of New Zealand is 14.5 million acres (22% of the total land area). In addition there are about one million acres of exotic planted forests on which Pinus radiata is the main species. This large and important (80% of the timber is now cut from the exotic forests) resource must be protected. The problem of a monoculture is well recognized by the local foresters and every effort is being made to prevent the introduction of serious pests.

Two groups of individuals are working actively on Forest Insect problems. The major group is attached to the New Zealand Forest Research Institute. This group includes five professional Forest Entomologists, several technicians, a professional Toxicologist, and a group of nine biological observers. The latter have responsibility for running surveys and for making evaluations as needed. The second group is in the quarantine service. These are the timber inspectors who are stationed at all of the ports. Their job is especially important to New Zealand because of the country's dependence on one tree species.

The number of insects of potential significance is very long. Many of them are ecologically interesting but I, of course, cannot mention more than a few examples. I will comment on twelve species which include a variety of kinds of damage; a mixture of both native and introduced species; and both serious pests and merely interesting insects.

1. Selidosema suavis -- This is a native looper which as adapted to Monterey pine. There have been two outbreaks of about 8,000 acres each on the South Island in Eyrewell and Balmoral Forests. The outbreak of 1960-62 was naturally controlled by a virus.

2. Heliothis armigera -- This is a common pest on horticultural crops in New Zealand. In 1967-68 it was discovered defoliating young pines. Since then it has been reared on pine foliage. Is this a strain that is developing?

3. Paropsis charybdis -- This chrysomelid is a serious pest of Eucalyptus. It was introduced from Australia in about 1916. It has definite host preferences but it could become more serious if more eucalypts are planted.

4. Proteodes carnifex -- This species is a defoliator of the native beech forests (Nothofagus spp.). In 1954 over 50,000 acres were completely defoliated. Mortality was not severe but those trees that died were also infested by a buprestid, Nascioides enysi.

5. Nascioides enysi -- This is one of two native buprestids in New Zealand. It has been blamed for beech mortality. In fact, the larvae are opportunistic and most mortality is of trees with greatly reduced vigor.

6. Eriococcus coriaceus -- This scale was introduced from Australia in about 1900. It is extremely destructive and at one time it was believed that Eucalyptus could no longer be grown. A coccinellid was introduced and since its establishment only occasional flare-ups have occurred.

7. Hylastes ater -- This introduced scolytid breeds in cull material and stumps in the exotic forest. The adult beetles kill young seedling pines by girdling them at groundline. The insect has also been a problem in the export trade.

8. Arhopalus ferus -- This cerambycid came from Europe in fairly recent years. It is attracted to logging areas, fire killed stands, sawmills, and lights at shipping points. In 1970 a difficult problem developed at one of the shipping points. All lumber was fumigated before overseas shipment to meet quarantine requirements.

9. Xyleborus saxeseni -- This is another export problem which came to New Zealand in cabledrums in about 1957. The insect attacks recently dead, moist wood and thus is attracted to logs ready for export.

10. Hepialus virescen -- This wood boring caterpillar of the moth family Hepialidae is a native pest of beech in the North Island. It is appropriately called the ghost moth because of the manner in which the larvae camouflage their holes. In some areas very few trees escape damage from this large caterpillar (3" long).

11. Sirex noctilio -- This is the most famous of all introduced New Zealand Forest insects. Between 1946 and 1951 this siricid killed between 25 and 30% of the pines in the center of the North Island. At the time the effects were beneficial as the forest was thinned. Damage can be minimized by careful silvicultural practices which keep the forest in a healthy condition. There is an interesting symbiotic relationship between this insect and a fungus.

12. *Platypus* spp. -- There are three species of *Platypus* on the native beech. These may exist in brood trees for many years and can result in serious wood loss and occasional mortality.

These have been examples of insects in New Zealand Forests and foresters there fear that more problems will develop as the years pass. The most immediate threat is apparently *Ips grandicollis.* This bark beetle is now established in South Australia. Many fear that it will soon reach New Zealand. It and other *Ips* species have been picked up at the ports on numerous occasions.

WORKSHOP: HOW EFFECTIVE ARE BARK BEETLE CHEMICAL CONTROL PROGRAMS, AND HOW CAN THEY BE IMPROVED?

Moderator: D. Hester

There was a lot of interest in this subject with more than 50 people attending the workshop.

Surprisingly, there was near unanimous opinion that chemical control was not very effective.

The mountain pine beetle and the spruce beetle consumed nearly all the time available.

There were few, if any, sound recommendations to improve methods of chemical control on the mountain pine beetle, rather, it was felt that stand condition and/or stand manipulation was the key to epidemics. There seemed little hope of practical chemical control without proper silvicultural practices.

The spruce beetle control centered more on trap tree methods rather than on chemical control. There was a much wider spread of opinions on this subject than there was on mountain pine beetle control. Some felt trap trees were very effective while others felt the method was highly over rated. A possible summation would be that trap trees are only one of the options to be considered.

Even after many years of study and work on these insects, it was quite obvious that we still have a long way to go.

One need came out rather clearly--we need to know more about stand conditions that can lead to destructive epidemics. Good guidelines here would help the forest manager in preparing long range plans for timber management.

PANEL: ATTRACTION OF DEFOLIATORS: STATUS AND POTENTIAL

Moderator: Mel McKnight

Panelists: Harry Shorey, Tom McIntyre, C. J. Sanders, Gary Daterman

Basic Principles of Sex Pheromone Attraction: Harry Shorey

Sex pheromone communication appears to be essential in order for the two sexes of many moth species to come together for mating. A male of *Trichoplusia ni* (the cabbage looper moth) will not respond to a female located a few centimeters away from him if he is prevented from perceiving her pheromone, even though she is extruding her pheromone gland and assuming a receptive position for mating. This need to communicate by a chemical through the atmosphere, then, is one of the elusive "weak links" in the life cycle for which economic entomologists search. If the males are prevented from finding females, the females will remain virgin and no subsequent generations of the pests will be produced. This rationale has led various investigators to develop a new hypothesis for the behavioral control of certain pest insects. Synthetic female sex pheromones will be disseminated in the field in such a way that males will be incapable of locating the females that are releasing the same pheromone. Pheromone will probably have to be continuously maintained in the air over a fairly large geographic area for a prolonged period of time, at a concentration well above the male behavioral threshold. Assuming that this behavioral control technique continues to look promising, the problem becomes one of engineering appropriate means for the quantitative and accurate dissemination of pheromones. Also needed are further biological studies, such as determination of the flight range of mated females in the field and the location of possible preferred aggregation sites at which males and females might congregate before pheromone communication takes place.

Synthetic Attractant Formulations for the Gypsy Moth: Tom McIntyre

Traps baited with sex attractant extracted from the last two abdominal segments of virgin female gypsy moths have been used to detect infestations of the insect for many years. Detection surveys in the past served as the basis for subsequent control activities aimed at delaying further spread of the moth. Collections and subsequent processing of many hundreds of thousands of insects were required each year to furnish attractant for the cooperative USDA-State survey program. In some instances, supplies of insects were not always available so that collections in Europe and North Africa had been necessary.

Dr. Morton Beroza and several coworkers in ARS recently reported the successful isolation, identification, and synthesis of the sex attractant of the gypsy moth. It is cis-7, 8-epoxy-2-methyloctadecane and has been named disparlure. The compound is not similar to gyptol or gyplure, previously thought to be the sex attractants for the moth. Disparlure was synthesized in December 1969 and was found to be extremely active in laboratory bioassays. Field trials were conducted in the spring of 1970 with laboratory-reared insects and the biological activity of the compound under field conditions was confirmed.

In the laboratory, disparlure was found to be quite volatile, evaporating in about 4 weeks at 25°C. To serve effectively in a detection trapping program during a minimum of 6 weeks, the volatility of the attractant would have to be repressed. Chemicals which Dr. Beroza calls "keepers" were used to regulate the volatilization of disparlure. The function of "keepers" is to regulate the attractant volatilization so that the attractant is dispensed at the same rate as the keeper from a given survey area until the mixture is depleted. Of the many keepers tested, trioctanoin was the largest available saturated fat that was liquid.

To characterize the performance of disparlure (plus keeper) early season field trials were conducted on Cape Cod, Massachusetts. Traps which had previously been aged for 12 weeks, 6 weeks, and less than 1 week were set out in a natural moth environment. Traps containing extract from moths collected in 1969 in Spain using the equivalent of 10 tips/trap served as a standard since this is the conventional detection survey trap used in the past for program operations.

The standard trap is initially much less attractive and also loses its attractiveness faster than the synthetic formulations. See the following table:

		Gypsy moths captured in traps aged:		
Attractant	Quantity	1 week	6 weeks	12 weeks
Natural extract	10 moths	11	6	0
Disparlure - trioctanoin	1.0 ug.	127	146	138
"	0.1 ug.	155	109	126
"	0.01 ug.	88	90	40
"	0.001 ug.	69	20	7
Disparlure - triolein	0.01 ug.	112	60	5

The disparlure-trioctanoin combination is clearly a very potent, long-lasting attractant. Substitution of triolein, one of many alternate "keeper" compounds tested, results in a less effective trap, which, is still 10 times as the standard trap using natural extract.

In other studies, the attractant power of a virgin female moth was compared to disparlure. Such tests were conducted before the natural moth flight to avoid interference from wild insects. The concentration of disparlure equivalent in attraction to a female moth fell within a narrow range, approximately 5 to 7 ug. disparlure. In these replicated studies, it was determined that disparlure at concentrations above 6 ug./trap (+5 mg. triochtanoin) could out perform the living virgin female moth. During these studies it was also determined that no repellency using 100 ug. of disparlure/trap was evident.

These studies in the spring of 1970 permitted an adjustment in the northeastern regional trapping detection program of that year. All traps baited with the natural extract were rebaited in midseason with disparlure. About 30,000 traps were involved. This further test with the attractant verified the stability and extreme potency of the new synthetic in areas in New York, Pennsylvania, Virginia, Maryland, and Delaware. Numerous male moth catches were recorded where previously the insect was not thought to occur.

The initial data on the new attractant has stimulated great interest among numerous research investigators who are considering methods for employment of the lure in control and suppression activities. Several possibilities for utilizing attractant baited traps in low level populations for suppression were outlined. Scientists believe in areas of incipient infestations, where insect numbers may be less than a few individuals per square mile, that trap suppression possibilities exist.

These approaches are predicted on the basis that traps can be made at least as attractive as female moths and perhaps this potency can be exceeded.

In a second approach to suppressing populations, a review of some of the earlier investigations of the so-called confusion principle were outlined (this discussion paralleled closely the research and investigations reported previously by Dr. Shorey). Methodology to be used in investigations in 1971 is still under study. Considerable work remains to develop suitable formulations of both liquid and solid carriers for the attractant. Considerable planning to evaluate these field trials involving population suppression has been completed. Since techniques are not available for the assessment of populations using traps, it is hoped that this new synthetic may be effectively employed in such investigations. This would prove to be an asset in the studies on population dynamics currently being conducted by Forest Service and other research investigators.

Preliminary tests on the toxicity of disparlure have been completed. In conventional studies with mice and rabbits, it is believed that this compound is completely safe for use in further field trials and research investigations.

Attraction of Forest Defoliators - Choristoneura spp., Status and Potential: C. J. Sanders

The spruce budworm complex includes six closely related species. Three of them, Choristoneura fumiferana, the eastern spruce budworm, C. biennis, the 2-year cycle budworm and C. occidentalis, the western 1-year cycle budworm, apparently share the same primary sex pheromone. C. pinus, the jack pine budworm, and C. orae, the coastal budworm, share a pheromone distinct from the first group, which may have some affinity to that of C. viridis, the green budworm.

Laboratory bioassays suggest that the sex pheromone of C. fumiferana is trans-11 tetradecenyl aldehyde, but confirmation of its attractant properties will have to await field trials in 1971. At the same time tests will have to be conducted to determine the optimum concentration of the chemical for maximum attractancy and to determine if a synergist is necessary to make the attractant competitive with virgin females.

The use of the attractant for trapping, while having considerable potential for survey work, appears to have its limitations for the control of populations in large outbreaks because of the areas involved and because of the required density of the traps. However, if outbreaks originate in epicentres and if these can be identified while budworm populations are still at the endemic stage then trapping may be practical either as a method of reducing the male population or as a means of luring males to a chemosterilant.

The use of the attractant, or an inhibitor, to confuse, habituate or inhibit male response may be feasible over wide areas, but would again be more practical if epicentres can be identified before outbreaks occur. Success will depend upon the uniform dissemination of the chemical throughout the habitat in a form that will maintain the optimum concentration during the 3 week flight period without deterioration of the chemical. Microencapsulation of the chemical in plastic, through which the chemical has a slow but uniform diffusion rate, offers such a possibility, but the use of this method will require considerably more information about the insect's behaviour than is at present available.

Status and Potential of Pheromones for Western Defoliators: G. E. Daterman

As a logical supplement to the preceding discussions, a brief look at what is happening with defoliator pheromones in the West, seems to be in order. In all of North America there are about 22-23 species of forest defoliators and other forest Lepidoptera for which a pheromone has been reported. Many of our important western species are not on this list. These include hemlock looper, pandora moth, larch casebearer, larch sawfly, cone moths, and various tip moths, to list a

few. In the United States and Canada, seven projects are underway on chemical characterization of sawfly or moth pheromones. Only two of these, European pine shoot moth and Douglas-fir tussock moth, are specifically concerned with a western species. Considering the comparative acreage and value of our western forests, this situation is unfortunate. It seems clear we should be moving faster in this area of pheromone research.

In considering the potential applications of pheromones for western defoliators, we are limited only by our imaginations. The obvious benefit is, of course, control by trapping or male-inhibition techniques. Use of pheromones for survey purposes, such as detection or monitoring population trends represents another type of benefit. Pheromone traps have also been used in studies on male sterilization techniques to evaluate the dispersal on treated plots by released, sterile males. By comparing recapture of sterile insects with catches of wild males from a population of known density, the degree of competitiveness of the treated insects can be determined. Pheromones have proven valuable for taxonomic studies in which closely related species were separated according to differences in response to particular pheromone structures. Pheromones have also been effective in establishing diurnal and seasonal flight patterns of certain insects. The point is, that pheromones can be helpful to many aspects of entomology besides control, and if we can eventually obtain synthetic pheromones for all our pest species, it would be very beneficial to pest management.

In considering pheromones strictly for control purposes, are there any conclusions or generalizations that can be made at the present time in regard to western species? I refer to this section as my "crystal ball" discussion, and the statements should be considered primarily as one man's opinion. To begin with, I'll venture that the male-inhibition technique (using an excess of the specific pheromone or pheromone masking agents) would generally be superior to adult-trapping techniques. A major advantage of the male-inhibition technique should be the ease of application. Spraying an inhibitory chemical for behavioral control of adults appears a simpler task than the distribution of traps, or other killing or sterilizing devices required by the adult-trapping method. This aspect seems especially important when one considers the terrain and accessibility problems in many of our western forests. Quite frankly, given a comparable cost situation, I've been unable to think of a defoliator, seed and cone, or plantation pest problem in which adult-trapping could be expected to be superior to the male-inhibition technique for control.

At this point, it might be worthwhile to consider a few specific types of insects and the potential of their control by use of pheromones or pheromone making agents. One basis for choosing suitable applications for control by pheromones might be the type of resource to be protected. High value resources with relatively uniform structure and

composition such as plantations, seed and cone orchards, and shelterbelts seem particularly applicable. A few species I consider applicable to control by pheromone behavioral control techniques are the fall webworm, Hyphantria cunea; tent caterpillars, Malacosoma sp.; seed and cone pest such as Dioryctria sp., and Barbara sp., and regeneration insects such as Eucosma sp.; Rhyacionia sp., and Dioryctria sp.

A few insects I do not consider as suitable condidates for this type of control are hemlock looper and insects which are normally bunched in close proximity during the adult stage. In the latter category, the larch casebearer, certain needleminers, and European pine shoot moth on ornamentals represent a few examples. The first example, the hemlock looper, usually is found in uneven aged stands having very dense canopies. Adults are often dispersed vertically from the base up into the lower crowns of trees 150 to 200 feet tall. How could traps, pheromones or pheromone masking agents be effectively distributed in such circumstances, particularly with a steep terrain factor thrown in?

Species that are normally aggregated in close proximity in the adult stage offer another type of difficulty. Adult proximity in a condition that I suspect does not lend itself to pheromone behavioral control techniques because of two factors, namely (1) the behavioral principle of summation of heterogenous stimuli, and (2) the "active space" as defined by Wilson[1/] cannot be sufficiently reduced to entirely prevent male to female orientation.

The principle of summation of heterogenous stimuli simply means that an overt behavioral act, such as mating, may be governed by more than one kind of stimulus. It is known for several species, for example, that mate-finding involves sight orientation responses as well as olfactory responses. In the absence or partial inhibition of one stimulus, the other factor(s) may assume a greater role. Thus, if we inhibit a male's olfactory sense, he may still have a possibility of locating a female through visual and/or other stimuli. If the adults are already in close proximity it would seem that such a possibility could be very high.

The "active space" of a species refers to the air space in which a single female of a species is capable of providing enough pheromone to induce a directed male response toward her under a given set of conditions (wind velocity). Under normal conditions a female may need provide only 10 to 100 molecules per cc of air to induce male response. If we permeate the air with masking agents or an excess of the pheromone; however, we cause an adaptation effect on the male's sensory apparatus to the point that it may require a "snootful" of

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1/ Wilson, E. O. 1970. In: Chemical Ecology. Academic Press, New York and London. pp. 133-155

pheromone approaching 1,000,000 or more molecules per cc of air to induce a male response. Since a single female cannot provide such a quantity of pheromone over any distance, we have in effect drastically reduced the "active space". My premise, however, is that even if the "active space" is reduced down to several cm, it might not be enough to totally inhibit mating. If we combine this consideration with the potential effects of the principle of summation of heterogenous stimuli, I think the overall effects to a behavioral control program could be very discouraging.

In the few minutes remaining, I will try and bring you up to date on the status of pheromone related research on European pine shoot moth. The chemical identification work is being done in cooperation with Dr. Doyle Daves, a professor of organic chemistry at the Oregon Graduate Center in Portland. Thus far, our study has resulted in the isolation and identification of primarily frustration and aggrevation. We do have a few answers; the compound is an acetate, has one or more double bonds, and probably has a 12-carbon chain.

We have discovered several synthetic 12-carbon acetates that work very well at masking the male's perception of the pheromone. Three of the materials, cis - 7, cis - 8, and cis - 9 dodecenyl acetates were especially effective. In laboratory tests we were able to significantly reduce mating efficiency and totally disrupt standard pheromone bioassay responses with these chemicals. In field evaluations, we were able to prevent male orientation to pheromone attraction centers by adding as little as 0.01 mg. of masking agent to the pheromone lure preparation (2 live females or extract of 10 female equivalents). One or more of these masking agents could possibly be developed for behavioral control of European pine shoot moth via the male-inhibition technique.

PANEL: REGIONAL AND NATIONAL VIEWS ON NEEDS AND JUSTIFICATIONS FOR INSECT CONTROL AS SEEN FROM: INDUSTRY, GOVERNMENT, EDUCATION, CONSERVATION

Moderator: Royce Cox

Panelists: E. P. Connors, Amel Landgraf, Oscar Schmunk, D. R. Macdonald, Ron Stark

Gentlemen:

This is to be a panel discussion concerning regional and national views on needs and justification on insect control as seen from industry, government, education and conservation. We have had a bit of a problem getting a final panel put together, with numerous substitutions, but I am pleased to say we have a blue ribbon group here this afternoon to present their thoughts on the subject. Our game rules are to allow not more than fifteen minutes for each of the panel participants to present their opening remarks; then to give the panel members an opportunity to cross-question one another, to make comments, to discuss the points they wish to cover. Following that, if there is time left, we will have questions and discussion from the floor. I hope we can generate some different concepts, much discussion, and maybe a bit of controversy, because it always stimulates our thinking, if we can keep it on a right kind of level, with a proper attitude.

Rather than introducing these fellows separately as they appear, I will introduce all of them to you now in the order on the program to avoid breaking the continuity of our discussion after we start.

First we have Mr. Edward P. Connors. Ed is a teacher at Country Day School in Denver. He has been involved with the outdoors for 25 years, and has been especially interested in environmental concerns the last 6 years. He has done several wilderness surveys in Colorado for the Wilderness Workshop of the Colorado Open Spaces Council, and he is presently the President of the Open Space Council.

Second on the program will be Amel Landgraf. Amel is a very able substitute for Dave Ketchum who phoned me just a few days ago saying that he couldn't be here. Amel is Assistant Director of the Division of Forest Pest Control, Washington, D.C. He's had long experience starting back in the sixties in entomological work.

Following Amel, we will have Oscar Schmunk, Deputy State Forester of the Colorado State Forest Service. He's been involved in entomological work in connection with his job for some time. He was appointed Deputy State Forester in 1968, served in the U.S. Navy in World War II, is a graduate of Colorado State University, and worked 2 years for the Forest Service before joining the Colorado State Forest Service in 1955.

Next will be Ross Macdonald. We are pleased to have Ross with us substituting for Jim Fetes as a representative of the Canadian government. He is currently program manager, including Forest Protection Research, for the Canadian Forestry Service, Victoria, British Columbia. He's been Project Leader in numerous studies in the maritime region.

To wrap up our panel, we have Dr. Ron Stark. Ron was born a Canadian, but much to the Canadians' loss and our gain, he became a naturalized United States citizen in 1959. Since July 1970, he has served as Coordinator of Research, Dean of Graduate Division, University of Idaho.

Our Program Chairman and Champion Ski Racer, Bill McCambridge, asked us to avoid getting into the fields of actual research and control projects, as such, but to confine our remarks to needs and justifications for insect control--in other words, the circumstances under which control is justified.

I'll start with just a few comments from an industrial viewpoint. I'm Managing Forester for Potlatch Forests, Inc., in Lewiston, Idaho. The first part of the admonition our program chairman gave us--to speak to the need for forest insect control--is not difficult. I will not delve into a lot of statistics concerning insect losses, because these are familiar to nearly everyone in this room. While fire is considered to be the No. 1 forest enemy, insects are so widespread that their total effect on tree mortality and growth loss is much greater than that caused by fire. This can easily be documented by consulting numerous reports. Forest products is one of the several basic industries which support the total socio-economic structure of both western Canada and the western United States. These basic resources include agriculture, minerals and petroleum, commercial fisheries on the coast, and not least, forest products. To me, it is a self-evident fact that before we can have jobs, food, shelter, and the monetary wherewithall to enjoy the numerous forms of outdoor recreation, someone somewhere has to raise an agricultural crop and convert it to something people can use, minerals or petroleum must be extracted and converted, and someone must cut a tree and convert it into one of the 5,000 various products that we take for granted in our daily lives. The subject we are discussing today has a very important bearing on this, because in the field of forest resources, without effective insect control, the costs of operating these forests in the face of worldwide competition cannot be kept within reason; we will not have the essential paper and wood products; and we will have a lower general economy. In Idaho, forest products ranks second only to agriculture. I have no statistics for the western United States, but, as you well know, it is still highly important. The forest constitutes the one renewable basic natural resource. Forest management is vital to the resource as is the research you are doing trying to come up with better answers to our insect problems.

Now with respect to the second request of our program chairman--to discuss justification for carrying out actual control programs--this is much more difficult because of the cost factors involved, and also because of the lack of proven, safe, effective control measures in many instances.

Of course, this is the whole purpose of these Western Forest Insect Work Conferences--to try to develop better methods. As a case in point, I'll cite the mountain pine beetle which attacks four of our major western pine species. In 1967 I estimated that the mountain pine beetle was killing 200 M board feet of white pine alone, annually, which if it could be saved would provide lumber for 20,000 average family dwellings. The need was obvious to me, but the justification to carry out a large-scale project simply wasn't there, mainly because we didn't have proven, economic control methods. Consequently, rather than attempt a large-scale control program using conventional methods, we decided to join with the Boyce Thompson Institute for Plant Research, the State of Idaho and private industry on new research to develop new synthetic attractants for use in potential control of the mountain pine beetle. Gary Pitman will report later in the program on the encouraging results of this research. My reason for mentioning it is that this effective, and much needed research grew out of a contact I made with Dr. Pitman at the WFIWC in Denver in 1965. I also use the point to illustrate that much more research is often necessary before we can justify actual control effort on some of our insect problems.

We will now hear from Mr. Connors who will present the conservationist's viewpoint. To my knowledge, this is the first time we have had a representative of this type of organization at one of these conferences. Early correspondence described Mr. Connors as a preservationist, later as a citizen conservationist--probably a more fitting term.

E. P. Connors (Colorado Open Spaces Coordinating Council, Inc., Denver)

Having the opportunity to appear at this conference, whether labeled preservationist or conservationist, black, white, gray, or what ever hat you hang on me, is both happy and potentially dangerous. If I can add to the conference as I would like, I should like you to fire back at me the kind of things you think the environmentalists should be looking at. I have an advantage in that there is only one of you whom I've seen before--I hope you haven't seen me before and I hope you haven't heard of me. Rather than think I am at the opposite end of the pole from any of you who are involved in lumbering, I don't mean to convey one viewpoint here. Instead, I should like to present to you some of these questions which many of you may consider naive. These questions

will be raised on an increasingly large scale by an alarmed citizenry who is demanding of industry and research.

The questions of what to do when a beetle infestation hits on federal lands is of utmost interest to all of us--the forester, the entomologist, the conservationist, and the casual onlooker. There is no question of the devastation in Colorado alone; this is probably what I know most about. I will therefore be a little parochial in my viewpoints I am sure. In Colorado alone between 1939 and 1954 there were some 4.7 billion board feet of timber lost to beetle infestation. It was represented to us that this would build some 690,000 modern three bedroom homes or 1/3 of the annual rate of the objective for housing. From a recent federal brief comes this statistic: Of the 57.5 billion board feet of lumber and plywood produced in the United States, 24 percent comes from the United States Forests. I wonder what percentage of that comes from Colorado? The trees all grew up in the upper montane and subalpine ecosystem in Colorado and it takes some 225 years for an 18 inch spruce to grow. Last summer I counted some 225 rings on an 18 inch spruce stump. During the years it took the tree to grow, the same houses that could have been built would have had to be replaced at least five times.

The question, then is: Are we replacing our wood fibre at the same rate we are cutting it? Or at the same time the little bad beetles are attacking it? We all look at a forest differently (fortunately) the esthete in terms of beauty, the lumbermen I am sure have many other ways of looking at a forest, many of us think they look at it in terms of number of board feet, and I suppose you look with delight upon what meal a woodpecker is feasting. There is a very definite concern among the environmental "kooks" like me, when we hear that an overmature forest is about to be saved by cutting it down because the occurrence of bark beetles is produced beyond the endemic stage and is found to be of epidemic proportion. How did nature survive, some of us wonder, without man's saving hand? Fortunately we have two parts of Federal lands where nature can take its course, the National Parks and the Wilderness areas. About six years ago there was a National Park committee founded for research and they came up with the conclusion that they recognize that National Parks are not pictures on the wall, they are not museum exhibits in glass cases, they are dynamic biological complexes, with self-generating changes. The attempt to keep them in any fixed condition, would be not only futile, but contrary to nature. Naturalness, the avoidance of artificiality should be the rule. One of the purposes of the Wilderness Act of 1964 is the scientific study of nature, and left in as natural state as possible though I think most of us would agree that there is no land left in the United States today which is left in a truly natural state without invading species of wildlife or vegetation. Thus to control or not to control insect infestations is a debatable question. Too many intangibles occur, but I "op" for the natural course,

at least in the Natural Parks or Wilderness areas. Woodpeckers, unseasonable cold, shift in prevailing winds, all have confined infestations in the past. This is the question in the Fourmile area of the San Juan Forest where 4,000 infested threaten to kill vast stands of spruce in the foreseeable future, including the areas of the proposed Weminuche Wilderness. Lee Yeager in his 1959 studies, however, showed there was much more vegetation of wider variation in species, much more small game, and more numerous birds in the dead stands of infested areas than in adjoining green forest. Also, Mr. L. D. Love, in February of 1955 indicated there was a greater stream flow from the infested areas over a period of years. Just last summer, here's where I'll probably leave you, or you'll leave me--my children and I were up near Trappers Lake just north of here and heard a tree fall in the forest naturally. I'm sure a lot of you have heard a natural tree fall, and other kinds of tree falls, but it might not transport you into spasms of ecstasy but it caused no end of excited chatter among us for it was only the second natural fall in my twenty-five years of woodsy romping, and I submit there is also a very unique beauty in a ghost forest. To quote from a 19th century poet, Mr. Ruskin. He said that great art accepts nature as she is, but directs the eyes and thoughts to what is most perfect in her. False art saves itself the trouble of direction by removing or altering whatever it thinks objectionable. Obviously I am talking primarily about Wilderness areas, the National Parks areas, and areas where there should be no controls. The dire predictions, for instance, in Yellowstone and Teton National Parks, the prediction of utter devastation to the lodgepole forest, by the ponderosa beetle, didn't prove out.

Having gone through the Wilderness areas of Yellowstone Park two summers ago, yet the one million dollars spent as of five years ago in the Teton National Park has only seemingly caused visual devastation of yellow strings, tags on trees, discarded pesticide containers and deadened understory. It seems that all spraying has been done with (and here you will probably cry I'm not right) has been with fuel oil based concoctions or with DDT. I submit that $50/tree on a non-foolproof method is a waste of money and man hours. Beside this, DDT and fuel oil haven't emerged lately as the long term saviours of the human race, have they? What if we didn't cut, or spray, or leave a lonely old trap log to attract all the bad old beetles? How devastated would the forests of the United States be? Mr. Cox just mentioned the numbers of acres of white pine. I'm sure there are both sides to this thing--how helpful over the years have inorganic fertilizers been to Texas cotton? Where will California's Imperial Valley be if they cannot dilute their mineralized irrigation water with Colorado's pure mountain water that Coors use so much on the East slope. These questions are very real and it is the kind of things a lot of us are asking. Will spraying a tree here, cause a counter-reaction here or further downstream, a reaction of which we are not aware yet. We are continuously seeing these things today. I hope we all practice

our chosen profession in the most professional way possible. I hope to teach and inspire into children values which make them good thinking citizens and Americans. Hydrology engineers often want to build dams because building dams is their business whether it's good for the overall United States or not, aeronautical engineers would like to build SST's and space vehicles to take a finite man out into infinite space, an oil man wants to build pipelines in Alaska. These things are all very real problems to us. We do need oil--no one in the environmental movement is saying we should just stop, that's the only way I got here today. On the other hand, we must think of the future implications of our professions and in the future lives of those who are to follow us, and hopefully this is exactly what our far-seeing entomologists are doing. As I mentioned before, I should like to play the role of the Socratean gadfly and hover about, and I hope you don't mind.

A. E. Landgraf (U.S.F.S., Forest Pest Control, Washington, D.C.)

Mr. Chairman, Ladies and Gentlemen, it is a real pleasure for me to be here, back out west again to participate in this conference, and renew old acquaintances. If I don't recognize you immediately, remember it has been about five years, and you may have changed a little, except for Murdoch here and Fred Knight, and some of the others who are holding up pretty well. I won't say more, lest someone might say that I've changed too.

Dave Ketchum asked me to extend to you, Royce, and Members of the Conference, his apologies for not being able to attend as he had originally planned. Some of you may know that hearings are being held on the Amendment of the Federal Insecticide, Fungicide and Rodenticide Act and Dave has been asked to testify. My job today is to discuss needs and justification for insect control.

I direct my comments toward two points, impact and control philosophy. Impact--what do we mean when we say that insects and diseases have an impact on the forest environment? Is the death of a tree or trees in a forest an impact? If so, what kind? Beneficial? Adverse? Aren't we trying to obtain information as to what effect forest insects or disease have on the forest enviroment? Aren't we also saying we will be concerned when there is an adverse effect? These are some of the questions we are asking ourselves. I'm presenting them to you for consideration. I can speculate that if I asked each of you in this room to define impact that the definitions would vary directly to the number of people in the room. Is this true? Hopefully not. I'm sure that we agree that reliable information as to what impact insect and disease has on our forests is one of our most critical needs. Management needs this information for a base on which to allocate dollars and manpower to highest priority jobs. I stress highest priority. As the world becomes more populated and the problems more complex, the needs of people

become greater, and the competition for the limited dollar resource becomes more acute. Each year we lack reliable information on the impact of pests weakens our ability to justify and compete favorably with others for the limited dollar resource, with which to carry out our assigned responsibilities. This is why we in Forest Pest Control have placed gathering of impact data on top of the jobs that have to be done. Most of you know that Forest Pest Control will be holding an In-Service conference in Washington, D.C. the last week of April. The theme of this meeting will be "Impacts of Insects and Diseases on the Forest Environment". In the course of three days we hope to define what we mean when we say "impact". Secondly, we hope to identify most of the variables that have to be measured to determine the net effect of a pest on the forest environment. We are looking forward to valuable input into this conference from forest insect and disease research, and forest economics and marketing research. We all have a role in deciding what information we need and how it can be collected. The second point I want to make pertains to control philosophies. Most of you know that Forest Pest Control bases control decisions on three criteria; biological evaluations, cost benefit evaluations, and an environmental statement. We recognize that cost benefit evaluations is one area we must strengthen if we are to make sound control decisions. Last winter we completed an economic analysis of spruce budworm control in the Rocky Mountains, Region 1, 2, 3, and 4 supplied us with specific information on outbreaks and this was the base for our analysis. We are now in the process of making an economic analysis of the mountain pine beetle control in lodgepole pine stands in the Rocky Mountains. We hope to have this completed by the end of this month. We plan to make similar cost-benefit evaluations of the southern pine beetle in the south and southeast and other western bark beetles that are of major importance, such as western pine beetle, Douglas-fir beetle, and Engelmann spruce beetle. Defoliating insects such as the gypsy moth, and the Douglas-fir tussock moth will also come under this analysis. We recognize that the information built into the early evaluations is limited. Even so, we feel we have a much better idea so that we allocated limited resources so we can realize the greatest return for our investment. The Environmental Policy Act of 1969 required that we involve the public and other governmental agencies in the planning stages of any program or project that will have a major impact on the forest environment. I think forest pest control, particularly our aerial spray job projects, that have been carried out by industry, or the States, or Forest Service, have done a very commendable job in the past. In our planning, we have involved the public, and other government agencies, prior to the final decision of whether we would spray or not. We will, however, have to do a better job than we have done in the past. As for Insect Control needs, we should, without overworking the phase, use an integrated approach to the problem of managing pest populations. On forest stands being managed for commercial timber we should continue to stress using silvicultural and cultural measures, the practices that would prevent or control insect outbreaks. Hopefully, the use of biological agents, such as insect pathogens, pheromones, parasites and predators

will play a greater role in future control efforts. We see them as promising pest management tools, and are looking forward to the day when we can put them into operational use. Some of these are quite far along, but we look forward to the day we can put them into actual practice. I think we all realize there will be times when we will have to use chemicals to suppress forest insect outbreaks. When we do, the chemical will have to be registered by the Environmental Protection Agency for that particular use. When more than one chemical is available, that which is least toxic to the non-target organism will have to be used. One of our major needs in forest pest control is insecticides that are selective, that are highly toxic to target pests, that are biologically active only for short periods of time, and are harmless to non-target organisms, including man. These are stringent requirements. However, they must be filled if we are to continue to use chemicals to control forest insects.

O. Schmunk (Colorado State Forest Service, Fort Collins, Colo.)

I will speak on the situation in Colorado rather than a Regional or National concept because this is what I am acquainted with and I don't know too much about other States. The history of insect control as far as the State Forest Service is concerned is relatively short, we've had control projects going back to the 30's, but these were relatively small projects, and very typical of ours, not too successful. The primary work we are doing now is in bark beetle control--we've had some defoliator type control projects, they were short-lived and of not too much consequence. In the bark beetle control, we got into this business actually by request from the public. I mean this literally, these people put money where their mouth was, they contributed funds to the State, they got local people to contribute and they also got the State Legislature to come through with a special appropriation to get us started. We do have a fairly strong mandate from the people, and we felt with this kind of concern we ought to go ahead. This was about in the early 60's and about the time I got into the business. In our mountain pine beetle control projects we are working with both species, the lodgepole and the ponderosa pine and if we can have the slides now I would like to switch away from timber types and talk more about use. When we talk about our beetle problems we may classify them into two different types: This is the forest or the remote area where we have the typical patch of timber that is being hit by the mountain pine beetle, the way it looks on the ground and the way we treat it. Now this ought to shake Mr. Connors up, there's a lot of chemical going up into the air and, of course, this is standard practice. The other thing I want to talk about is forest residential. Now when you talk about houses in trees, or trees among the houses (I don't really care) but these houses were placed in the natural forest. This is the Dillon project that we've been into for about five years. You can see the dead trees--it is a mountain residential type--very typical. All types of trees are dead, this man has lost 90 percent

of the trees around his particular lot. He's not very happy with us, the insect, or the trees. It doesn't make any difference to him. We have a lot of problems, and in the forest the lodgepole pine is a new one to us, we've not had the mountain pine beetle in Colorado, at least as far as we know, in the last few years we've picked up infestations in various locations in the State, rather widely scattered. We're concerned, we have a large lodgepole pine type, we don't know how it's going to affect it, or whether we are going to lose it all, or just a part of it. We do not have markets for the lodgepole pine, in generality, I'm talking primarily of private lands, these trees are not of commercial size or the land ownership patterns are such that we cannot handle them and we usually cannot get a logging operation going. The ownership pattern is important to us, as we can have from 1 to 100 landowners involved in a mountain pine beetle infestation, and this is complicated by the fact that most of them do not live in Colorado so it is a communications problem all across the board. What does a forest residential site look like? What do you call forest residential? This is one type, these are rather old trees, these people are concerned--they built that house framed by those two trees, obviously one is gone. Here we are spraying in close proximity to homes, the fact that we use an oil-based chemical is a problem. We're congested when we talk about spraying operations, and if you talk about felling this makes us crawl the walls right away. Every tree has to be tagged because we do bill the landowner for the spraying operation, and it's a pretty costly, time-consuming operation. We get into problems with powerlines, this is a relatively simple one, where you have powerlines on three sides of a tree you start worrying about it, or a tree growing up through somebody's living room, you really have problems. The mention of fuel oil brings to mind this kind of a problem--daisies are highly susceptible to fuel oil, so are lilies, so, by the way, are most vegetable gardens. We have sprayed trees in the middle of vegetable gardens, washed off the gardens afterward, tried to protect them as much as possible--the people did eat the vegetables afterwards, and I assume they are still alive. Then we do have the attendant slash problem, in and around mountain subdivisions. What do you do with this when we have an air pollution ban? We can't burn it, there's not market for that stuff, and you can't bury it on Forest Service landfills any more, so we are tied in every way we can possibly think of. We do have an adequate supply of firewood. I'd like to talk very briefly about these changes in pesticide restrictions or from public concern (pressure) whichever you like to call it. We're trying everything we can, and some of our methods are rather crude, these are Bill McCambridge's blocks of ponderosa pine that we charge with beetles and we hang them on trees to form an attractant so we can pull beetles out of high value areas. We've had some success with this, it's crude, but better than nothing. We've tried the Silvisar treatment with about equal success and failure. We do use a lot of the chemical. We have gone to power sprayers to cut down our costs where we have good roads, and good systems to get in and out of the Forest. This looks promising, but now we are told

that next year we will not be spraying so maybe this will be out of the picture and we will be going to this type of operation which is cut, buck, and limb out every tree and handle it with a sprinkling can...

We need to know a number of things before we can determine need and justification. We know that ... We also feel the need because the public is concerned. I might state that we tried a questionnaire in a very high value residential area--Grand Lake area, some of you have heard about it, we have a mountain pine beetle infestation started there and we asked the people: Should we leave it alone, should we spray with chemicals, or should we log? Answers: Save our trees, don't spray, don't log, don't leave it alone, so we really don't know what to do. We have a real problem in cost to the private landowner of removal of materials from the area. The fact that you don't use tax money in controlling a beetle infestation does not remove the cost to the landowner. If he loses 100 trees and it costs him $50 a tree to drop those things, he has had a substantial loss, and if he bought the property because of the trees, it may be so devalued that he can no longer sell it or regain his original investment. To complicate it, you can take mountain pine beetle, and we have some mixed classes, we have had one neighbor lose all of his value and his neighbor lose none. Though we may have treated neither man's trees, the man who loses his cannot understand why we didn't treat his. It all comes back to the law--in Colorado it is very explicit, it says we will protect the forest resources of the State, both public and private, from fire, insect, and disease. We interpret this based on public concern. If the public is not concerned about it we are not going to do anything about it. It's as basic as that. We would probably modify this if our lack of concern or our lack of control would endanger other public lands not under our control. Here I am thinking of an infestation on private land that would spread to National Forests or to the Parks or something of this type. We have to think about protecting other resources and this is one of the tough things to do. I still have to talk about methods, but one thing I would like to say is that the method we use is often the determining fact of whether we are justified in having a control project, so a change in pesticide use, a change in operating procedure, may increase the cost to a point where it's prohibitive or where we cannot physically do it. Therefore, we need to know what types of methods are available to us, with enough advance notice so that we can get the field operations going. We also need to know what type of results we are getting from our insect control programs. This was mentioned in the workshop immediately preceding this panel, and I would like to add that we also need to know why we failed or why we succeeded, because we know people are not entomologists, and we need this information, and quite often we do not get it. We get excellent cooperation from Bill McCambridge. He tells us very frankly "you did a lousy job, and this is why". This is more what we need in the field. We need information on the cost-benefit ratio. If you can come up with cost benefit ratio on

recreation land that is selling for $25,000 dollars an acre I'd like to see it. We need to know how long we need to hold these trees in mountain residential areas before better methods of control can come down the pike.

R. Macdonald (Canadian Forestry Service, Fredericton, N.B.)

If some of my presentations seem confused, it is because of stories about other people who were going to do this job, they are always very kind to sell the Tel-X but not the notes, and to top it, I did see the letter outlining this program at coffee break, so that's part of it, and the other part is that the Canadian situation is somewhat confused anyway. Just to give you a frame of reference, I'm a Federal Civil servant and there is a very large difference between the situation in the States and that in Canada. Essentially 80 percent of the productive forest is owned and managed by the Provinces. The Federal Government is not responsible for Forest Management or protection except in parks, military reserves, and some Indian lands and territories to the north, some research establishments. Nevertheless, the Canadian Forestry Service has been engaged in studies of forest pests through surveys, biological investigations, damage appraisals, chemical and biological control, and research for over 50 years, in cooperation with Provincial forest services and forest industries. The Canadian Forestry Service is generally relied on for advice whenever potential control problems develop. Nevertheless, Canada does not ordinarily undertake control action itself. However, it may cooperate through cost-sharing arrangements between the Federal Government and the Provincial governments. In most instances, industry contributes to the Provincial share of the costs. So in the past, we've often had a three-way split. All projects in which the Federal Government participates financially, a critical review is made by an inter-departmental committee before forest spraying operations to assess the potential benefits, the side effects, and the alternatives. This committee dates back to about 1954. It represents the various Federal Government agencies, with responsibilities to fisheries, wildlife, hazards to humans, forestry, etc. It used to be quite.... but now we have all been combined into what any day now will be a new department, the Department of the Environment. Within this department there will be elements that will be responsible for actually managing a resource, such as our fisheries people, ... migratory bird population, ... migratory bird convention, the only question is the Provinces enforce it. Then we come to the control projects that are not partially financed by the Federal Government and the experience today has been that these are reviewed by the committee I mentioned, and for the most part the Provincial agencies have found these very useful as the expert advice is brought to bear on the situation. At the present time the government of Canada is reviewing its policy of financial participation in pest control operations. It did not support projects against spruce budworm in New Brunswick and Ontario in 1969 or '70 although it did support

a project against Eastern Hemlock Looper in Newfoundland in '69. At present I believe there are no intentions to contribute to projects against budworm in Quebec, New Brunswick and Ontario in '71. There are, incidentally, 20 million acres infested with budworm eastward from Ontario. This is probably a good time for the Minister and the Federal Cabinet to review their policy, because they are certainly going to be under more pressure. In spite of this apparent withdrawal of the Federal financial support from control operations the Canadian Forestry Service continues to provide expert advice, service and research to the various Provincial governments for the justification, operation, and evaluation of various control projects. I'll probably be talking in this regard from here in. Basically, the objective for spraying in Canada has been to prevent serious tree mortality from occurring in economically productive forests. The need and justification has been to prevent serious disruption of the social and economic order in a region through loss of stumpage, changes in cutting and management plans, reduced value of products, lower tax revenues, changes in the sources of supply, the redeployment of labor force to other regions or industries. We've got some pretty startling examples of this, a sample one was the removal of the New Brunswick hardwood industry which was a major one, to Ontario, about twenty-five years ago because of birch die-back. There's a workshop on Thursday afternoon that goes into this a little bit more. I'll just synopsize with spruce budworm cost-benefit work in New Brunswick. It was estimated that under normal circumstances the forest production in central New Brunswick would exceed 500,000 cunits annually by 1980. The spray program for 1960 and this was written about 1967, we had to do a cost benefit analysis for treasury board and it was estimated that if the spray program had not been undertaken, some 400,000 cunits would be lost annually from production by 1980, resulting in some 2,400 man years in employment in an area that was already very severely handicapped economically in relation to the rest of Canada. It was estimated that production would increase gradually but the forest would not return to its full potential till some time after the year 2000. Chris Saunders showed a map that showed this outbreak or part of it. He referred to it as one outbreak, but I prefer to think of it as two outbreaks. I had to do a report for the treasury board and had to go out on a limb and say that the outbreak would be finished by 1970...third outbreak. I would defend it on other ground, but I still think it's a third outbreak. Spraying has usually been undertaken when it is thought that another year's defoliation would result extensive mortality. This criterion was adjusted upward in New Brunswick in the mid sixties to prevent top killing, on the expectation that the demands for wood precluded the potential losses through decay that could be anticipated...as these projects have been successful in keeping trees alive. There have been a couple of interesting departures from that objective and they give a clue to the future. I think we are all looking forward to the day when we can predict the population change in time and place with some measurable accuracy. We had a good panel on that earlier this afternoon. Ability of predicting and detecting incipient outbreaks or epicenters. There is a school of thought that these should be treated before they break

out into full-scale outbreaks. Blaise reported on one such case in the Gaspe in 60, 61, and 62. There was always a question on that one because it could have been a residual from an outbreak in the 50's. We treated an outlying infestation to the central New Brunswick outbreak the same way in the mid sixties. The same dope (?) was associated with the results. Indications have come from northwestern Ontario that an outbreak was treated in '68 and '69 with apparent success. I understand there are new infested areas in northern New Brunswick. The eastern Gaspe will probably be treated in '71, to prevent population buildup, however it has not been infested since 1959. I expect that preventive treatment will be regarded as a very desirable approach. It might take a decade or more to get people thinking that way, once some of these outbreaks get rolling, as they have to wait until the next time around. To mention that some 20 million acres are likely to be infested in eastern Canada this year, spraying operations are planned in New Brunswick, Quebec, to a lesser extent in Ontario. I understand that in Ontario some of the outbreaks can be described as massive, 4-1/2 million acres or thereabouts, volumes of host trees are low and spraying if undertaken at all will relate to protection of recreational areas and to those areas where there is a high volume of spruce and fir. I understand also there is some concern over the fire hazard created by the destruction of trees by the budworm. This is always a pretty good by-product. Lloyd Sohata can fill us in sometime on the situation as it stands now. To sum up, in Canada we are frequently faced with massive outbreaks of destructive insects in regions where the economy is almost entirely dependent upon the forest. We have sufficient examples of the disruptions these outbreaks cause to the economy and to the social order and conclude that action must be taken to protect the resource. Ensuing benefits derived from protective action, the reduction of the risk of fire, development of management for lower susceptibility, only strengthen the benefit ratio derived to protecting the capital resource. The cost in terms of cash outlay, in terms of undesirable side effects attributable to pesticides, will be kept minimal through constant critical review of program planning and operation through application of sound research. I think that's essentially our experience in Canada, Mr. Chairman.

Mr. Stark · (University of Idaho, Moscow)

Some of the advantages of being the last speaker, of course, is that you don't have to repeat what's been said before. That's what I've been doing over here--scratching out and re-writing. My remarks will be mercifully brief because a lot of the things I would like to say have already been said.

I am supposed to present the viewpoint of an educator. In thinking about this panel I had some difficulty separating needs from justification, but finally decided the justification is just a back-up for a decision that there is a need. We make the decision that there is a need, and then write a justification. We do it all the time in grantsmanship.

The universities, practically all of the universities I know, have written into their letterheads, teaching, research, and service. These are three prime functions of the university. In the current jargons of popular systems analysis I think this is called a continuous loop as they are not independent of one another, they are supposed to interact. To help you ascribe a single one word definition of the function, I think you'd have to use "educate." But whom? Some feel our responsibility ends with the diploma ceremony, that once we give the man a certification that Mr. X is now an expert forest entomologist our responsibility is ended. These people should be able to analyze need, convert this to justification and hopefully, to action. Judging by the frontage of forestry and agriculture today, we have not done a good job in the past, and perhaps we are doing a slightly better one now, I feel that the criticisms now leveled at past and present justifications for control are somewhat correct. But even if they are incorrect, at least they are now questioning, a little more than they used to, and I think this is healthy and valuable. The universities should also extend their education outside of the confines of their campus, to a public sector of the ... work force. The public is just plain ignorant of the issues involved. I think there is no question about this. I think Oscar's remarks about the questionnaire demonstrate this beautifully. That we, presumably the prime educators of the public, have not educated the public. In past years at various work conferences and various pest action councils, I've heard of refresher courses, retraining sessions, etc., for Forest Service and industry. What a great idea! To my knowledge, this has remained just talk. Many of our forest managers and decision making personnel are of relatively ancient vintage, like myself. Our rules are written in a different era and with usually only one set of values considered. We may be largely unaware of recent advances in control, other than those in which they were trained, depending on your vintage, primarily chemicals. So though this is not specifically to the theme, I think from education's point of view, the greatest need is to control control as we now know it, through our education system, by training new blood, by educating the public, and re-training existing personnel. This training should include in its curriculum a course in perspective, when defining needs more than one perspective is necessary. One particular perspective will prevail but it has to be justified in the context of all other perspectives. We have heard many of these perspectives today from the speakers on the panel. These include the protection of jobs, protection of esthetic values, etc., etc., etc. In many universities, theoretically at least, you have present the ... capable of examining needs and priorities from all perspectives. Remember I said theoretically. The most crying need seems to be to define need itself. Who needs what, and what is what? Judging by the comments made by the previous speakers, particularly those from the Forest Service and the Canadian representative, we are taking steps in this direction. However, each vested interest sees need through its own perspective. The university presumably has no perspective interest if you read their collective insignia, they just bask in the light of reason. The view of this educator at least, is the university should take the lead role in providing the forum for focusing all perspectives,

to one palatable, to a majority at least, for each problem in turn, to determine whether national priorities override regional priorities. To determine whether regional priorities account for all components of the region. To see, in the name of control, that unforgivable insults are not made on communal, regional, or national resources ... their desires. This will involve the three functions of the university: teaching, research, and service ...

Mr. Cox:

Rather than to take time to summarize these remarks, we'll go on to a discussion among the panel members themselves. Mr. Connors, you were first. No one has attempted to answer your very pointed questions, and I think when we get into the panel discussion, some of these will come out; if not, I'm sure there will be some offerings from the audience. However, if you would like to make a few comments before we move on, we'll be pleased to have you do so now.

Mr. Connors:

I'd like to basically learn from this short afternoon that I'm with you, maybe from the floor and from the panel. I'm reminded of a story, I think it's apocryphal, but I think it fits this, of the man who was virtually stranded on Lake Erie because his cabin cruiser ran out of gas. A storm was coming up and he had no way of getting in to shore until he looked into his handy-dandy liquor locker and found a case of Scotch. He started pouring the Scotch down the gas tank until he got the engines going again, he was a little low on Scotch by the time he got back in, but he did get in. The point of this is that it didn't help the boat much. I wonder what we can come up with on some of these presentations and I'll be the first to admit that I know nothing about it, but I would hope you do. I would ask, maybe among the panel, the questions again. Before we go about hazard spraying, or saying that this works, we'll wash off the lettuce afterwards, or something like this, this seems to me, from a non-technological viewpoint, a very haphazard way of going about things. I wonder about testing programs, I'm glad the product can be removed from usage by the Federal or State agencies. I think this is something that involves a lot of us, as I say, who do not have the technological background but look to you who do to come up with the answers, before, not after. I'm sorry we lost all that understory, but I had the feeling that the ponderosa pine in the picture was lost because the guy put a retaining wall around it, and the surface roots were gone rather than the fact that the beetle hit it, but, anyway, it might have done it. I wonder if we could address ourselves to this question.

Mr. Schmunk:

This comes back to the basic problem, we really don't know what the people themselves want us to do. The washing off of the lettuce is not for the chemical; it, we know, is relatively safe, the diesel oil is enough. I've heard entomologists say that they'd eat all the EDB that comes into my mouth, I won't worry about it, because it's

already stabilized as far as I'm concerned. I don't know how to address myself to the problem, especially since we have the people moving into the mountain area, we are pretty pragmatic about it, we are not going to control that, not to the extent of keeping people out, although this suggestion has been made. But you must understand that Colorado is going to have the Winter Olympics, if you think that hasn't created a furor. Most of the pictures I showed you are of areas that are going to be affected by more people. The agriculture people are saying, don't put people down on the agricultural land, save it for future generations. The watershed people are saying keep them off our watersheds because you are polluting our water supply. All we're trying to do is come up with some sort of answer that will take care of all of these problems, and I must admit we don't have the answers. I don't think we are going to get them immediately, but I think we can work on it. As far as we can tell, from the general public's requests, we will act on them and we have to do this. Some of you may feel you are free agents, but we feel we are public servants, and we must do it. The little old lady who says we will treat that tree, even though it is in her garden patch, even if she wants us to wash the windows and clean off the lettuce,we are going to treat the tree, wash the windows and clean off the lettuce. We like to eat, too. If it is going to harm her, or other people downstream, as nearly as we can tell, we will probably not do it. We have taken that approach, of course we have to rely on other people for this sort of analysis. We can't do it all alone. We have stayed away from fairly persistent chemicals, we have used them, we feel that we have used them legitimately, and carefully.

Question from floor:

You say that EDB spraying will not be done next year, I wonder if you could elaborate a little bit on why this is so.

Mr. Schmunk:

As I understand it, this is mostly hearsay, I have nothing official that EDB will be taken off from spraying with either pumper spray or stirrup pump. We must apply it with a sprinkling can, and evidently this is primarily because of diesel fuel carrier--a problem to the understory and to other plants. EDB as most of you.. is the chemical used to treat grain so you don't get weevils in your breakfast cereal. We feel it is a relatively safe chemical as far as the forest is concerned. If this restriction is placed on us, we'll have to go along, or go strictly on a State control program, though I imagine that would be short-lived too, as I'm sure the State Legislature will follow the Federal.

Question from floor:

When you said you would be enjoined against spraying, you meant standing trees?

Mr. Schmunk:

Yes, we can still use the spray on felled trees, but this triples our cost.

Question from floor:

At what percent will public reaction govern action? 51 percent, three-quarters, or 100 percent, before we can go ahead?

Mr. Schmunk:

We've had no success in analyzing public reaction, we give them one alternative and they come back with four or five. We are trying, through our universities, to get some sociologists and people like that involved, to let us get a handle on this particular problem. But we have no success. Question about cost-benefit ratio is largely unintelligible.

Comment from floor:

One way to control beetles without chemicals is to cover the infested portion of the bole of brood trees with plastic sheeting before beetles emerge. This is expensive but it may be justified in such areas as described by Oscar Schmunk.

Mr. Cox to Mr. Connors:

You asked two important questions. One pertained to natural control of insects through wildlife (woodpeckers, etc.), predator insects, cold weather, and things that nature did before man was here. The other pertained to what happens if you leave a forest alone? These two questions tie together and I think you deserve an answer--does anyone wish to respond?

Mr. Stark:

It is a common fallacy that trees can be preserved indefinitely. Natural controls are inadequate and trees must die sooner or later--from insects, disease or old age.

Mr. Knight:

This is a subject to which I have given a lot of thought over the years. I agree with Ron Stark that a forest of balsam-fir or balsam and spruce would eventually be killed by the spruce beetle or the spruce budworm. I think it is a mistake tht a lot of citizens make (and I include us in the concerned citizenry about environment too) when they exclude people as a part of ecology. What do we do with the balsam-fir or the spruce here in Colorado, if we are concerned about people? We have two choices: We can allow the trees to die a natural death by the spruce beetle, which is perfectly all right if we are not going to need the trees for anything. Or we can say

we will substitute humans for the spruce beetle, which, in effect, is what we are doing when we log a forest. Either the human cuts that overmature spruce or the spruce beetle kills it. We have to make a choice. Do we need that spruce or not? In my talk this morning, I stated that the beetle infestation on the White River Flat Tops was probably a benefit rather than a harm to the Flat Tops. I agree that it is nice to hear a tree fall down by itself (I've heard hundreds) because no one is going to be using that forest for a long time. From what Bruce Murdoch tells me, there is a nice young stand of spruce growing among the old, dead trees now, so to that extent the beetle was a benefit. However, in another area where we do need to use that forest, why shouldn't we use it? Why should we let the spruce beetle have it when we might as well have it ourselves to supply human needs? We are part of the ecology and our needs should be supplied as well as the beetles' needs. If we can make use of that forest without damage to the environment, why shouldn't we?

Mr. Connors:

There is a very definite need for a viable timber industry in the State of Colorado. We need Parks and Wilderness Areas too for Professor Stark's students to go on field trips, but I agree that outside of designated areas there should be areas left for timber industry for the human beetle.

Mr. Cox:

Remarks re closing the panel:

I should like to make one brief remark in regard to the fine way in which Mr. Connors presented himself to us here today. I think it has generated a lot of good discussion. I have a strong feeling that there should be more of this sort of interchange among the various groups. You mentioned the Forest Service in Montana--I happen to be fairly close to that. The Forest Service, in my view, does need to respond better than they have to date, and hopefully they will. You've asked some very pointed questions, Mr. Connors, and I hope you have been given at least some partial answers. How about going the other way, and inviting some of this group to your meetings, and have your people ask them questions, and get this exchange of knowledge? Communication, or lack of it, is the biggest problem in the world. If you don't communicate with your wife, sooner or later you get into trouble. If we don't communicate with the public--with the groups that Mr. Connors represents, and other groups, we are going to get into serious trouble. We have to get with it, fellows, and do more of this communication. I hope, Mr. Connors, you feel the same way.

Mr. Connors:

I should be happy to have members of your group come to our meetings. I will get together with Mr. McCambridge and try to arrange a mutually convenient time.

Meeting adjourned.

PANEL: BARK BEETLE ATTRACTANT TESTS OF 1970

Moderator: Galen Trostle

Panelists: Jack Coster, W. D. Bedard, Jerry Knopf, Gary Pitman, Walt Cole

Frontalure Tests in SE Texas, 1970: Jack Coster

Frontalure, a formulation consisting of the southern pine beetle attractant frontalin and a host tree compound alpha-pinene, was deployed at infested southern pine beetle spots in Texas to supplement salvage or harvest control methods in use against the southern pine beetle. The Texas Forest Service and forest industries operate an intensive bark beetle detection, survey, and control program into which it was decided to operate the frontalure pilot tests.

The silvicide, cacodylic acid, was also utilized at the same time in the control scheme. Trees baited with frontalure at the infested spots were also injected with cacodylic acid. The silvicide rapidly kills the tree and renders it an unsuitable host for development of the brood that result from the attracted beetles. After aggregation is complete at the beetle spot, salvage crews remove the trees to the mills.

Although the tests were conducted under endemic population conditions, the limited testing available in 1970 was encouraging. In all cases, aggregation at the test spots was rapid and resulted in the destruction of the dense broods in the cacodylic acid treated trees.

Western Pine Beetle in California: W. D. Bedard

The efficacy of the synthetic attractant mix, exo-brevicomin plus frontalin, plus myrcene, for the suppression and survey of the western pine beetle was measured in a pilot control study at Bear Lake, California. The study was a joint undertaking of the U.S. Forest Service, the University of California, the California Division of Forestry, and the Pacific Gas and Electric Company. Populations of the western pine beetle and its insectan natural enemies and associates are being measured throughout the 35 sq. mile study area for four successive generations, one preceding suppression and three following. Over 250 suppression traps were erected in four one-half square mile suppression plots on an eight-chain grid. Over 100 survey traps were placed throughout the study area on a 40-chain grid. Traps were erected before spring emergence, and suppression traps were removed at end of spring flight, while the survey traps remained out for the duration of the entire flight season.

The data are not completely gathered and only partially analyzed, but these preliminary results are available. We started with over 100 infested trees before the treatment. Now, two generations after suppression treatment, we have located only five infested trees. Suppression traps trapped 427,000 western pine beetles while the survey traps caught 330,000. One hundred and fifty trees were attacked adjacent to suppression traps, but only 15 or so were killed. We feel these preliminary results are very promising.

Field Evaluation of a Bark Beetle Attractant-Frontalin, Douglas-fir Beetle, Coleoptera, Scolytidae: Jerry Knopf

Periodically populations of the Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopk. cause severe losses to Douglas-fir stands in the Intermountain Region. Winter storms of 1964-65 toppled thousands of trees throughout southern Idaho. From that time until the present, losses have increased annually from this destructive pest.

The epidemic status of the beetle was clearly outlined during the Intermountain Pest Action Council Meeting; Sept. 1969 at Boise, Idaho. During this meeting a Douglas-fir beetle action committee was created to explore short and long range methods of combatting the Douglas-fir epidemic. This committee agreed that all avenues of control be investigated, and in particular singled out the development and testing of pheromones.

Recent developments indicated that the pheromone frontalin plus host terpenes caused aggregation of adult Douglas-fir beetles. A cooperative administrative study was undertaken with Boyce Thompson Institute, Grass Valley, California to field test frontalin. The objective of this study was, "To determine if synthetic frontalin plus camphene and alpha pinene causes significant attraction of in-flight populations of the Douglas-fir beetle to pre-selected, baited, host trees."

The study was conducted on the Trinity Ridge timber sale, Atlanta Ranger District, Boise National Forest, Idaho. Logging of study units was deferred until July 15, 1970 when the majority of adults had flown. Sampling of infested bait and check trees plus logging of study units continued from mid-July through late October.

Douglas-fir beetle response to Douglure[1/] was clearly demonstrated during this study. In-flight populations of beetles were vectored to pre-selected bait trees which in turn were mass attacked. This

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1/ Douglure--a mixture of frontalin, camphene, and alpha-pinene

conclusion is supported by the fact that on June 25, 1970, 100 percent (157 trees) of the bait trees had been mass attacked. Conversely only 13 or 8 percent of the 154 check trees were attacked.

Attacks eventually spread to trees adjacent to baits killing 58.5 percent of those which had a d.b.h. of 4 in. or larger within the 33 ft. radius study plots. Only 3.6 percent of trees adjacent to infested check trees were mass attacked.

Further large-scale field testing is needed to determine the effectiveness of Douglure as a survey or suppression tool.

Results of 1970 Studies on the Mountain Pine Beetle in Idaho: Gary Pitman

A mixture of trans-verbenol, the principal volatile constituent of female D. ponderosae hindguts, and a host terpene alpha-pinene were again proven effective in manipulating mountain pine beetle in the white pine stands of northern Idaho. Research from 1969 was expanded to dead-trapping responding beetles. Several trap designs, including various sizes of cylinders and plywood panels were tried. The most efficient trap was a simple 3/8 in. plywood panel, 1 x 4 ft., covered with Stikem Special and baited with attractant-charged polyethylene tubing and plastic bottles. Previously it had been found that the major portion of a limited population of mountain pine beetle could be drawn to white pine baited with pheromone on 132 ft. centers. This pattern of grid baiting was modified in 1970 for simplicity and economy of attractant deployment by baiting white pine on ca. 1,800 acres in groups of 2 - 6 trees on 100 ft. contours at 200 ft. intervals. This method was efficient in terms of pheromone deployment, however, was less effective in inducing attacks on baited trees. In two 40's using sticky traps deployed on contours, an approximate 50 percent reduction in tree mortality was noted from the previous year's losses. In adjacent 40's which were untreated or in which white pine were baited, the volume lost was comparable to the preceding year or sharply increased.

Tests on lodgepole pine in central Idaho with trans-verbenol and alpha-pinene caused mass attacks on over 50 percent of the 240 baited trees. However, the ensuing attack "spilled" over to adjacent trees, resulting in the loss of several hundred more trees. It appears that principles developed during the last five years on mountain pine beetle manipulation in white pine may be applicable to lodgepole pine-mountain pine beetle infestations as well.

The Use of Trans-Verbenol and Alpha-Pinene for Attracting the Mountain Pine Beetle to Small Diameter-Thin Phloem Lodgepole Pine Trees: Walt Cole

Abstract:
Lodgepole pine trees (Pinus contorta Douglas) 8.9 in. d.b.h. or less were baited with the pheromone trans-verbenol and the terpene alpha-pinene to determine if populations of the mountain pine beetle (Dendroctonus ponderosae Hopkins) could be attracted to trees of small diameter. This beetle prefers the larger trees where it reproduces itself in greater numbers. Although the baited trees were usually the first to be attacked, the attractant was not effective in inducing mass attack of the baited tree. The results implied that trans-verbenol and alpha-pinene are effective in attracting mountain pine beetles to small diameter lodgepole pine trees. This is substantiated when the ratio of attacked trees, by diameter class, is compared between years; i.e., there was an increase in number of small diameter trees attacked during the attractant test over the previous year when no attractant was used in the same area. The attractant also was effective in attracting beetles into the immediate area of the baited tree when the majority of attacked trees were of the larger diameters.

Conclusions:
Trans-verbenol and alpha-pinene were effective in attracting the mountain pine beetle to trees smaller in diameter than those which the beetle most often attacks although many of these baited trees were unsuccessfully attacked. A greater percentage of trees 8.9 in. d.b.h. or smaller were attacked during the attractant test than occurred in the previous year, and in most cases the baited tree was attacked before any other tree in the immediate area. However, the beetles' strong natural attraction to larger diameter lodgepole pine trees seems to be greater than the attraction of a small tree baited with trans-verbenol and alpha-pinene. Consequently, trans-verbenol and alpha-pinene appear to be effective in attracting mountain pine beetles into the area of a baited tree but not necessarily in great enough numbers to the baited small diameter-thin phloem trees to be used as a population reduction tool. Additional research with this pheromone for mountain pine beetle management is warranted.

Acknowledgments:
The author thanks Dr. Gary B. Pitman of Boyce Thompson Institute for Plant Research for providing the trans-verbenol, alpha-pinene, and technical advice.

PANEL: STATUS OF REMOTE SENSING IN FOREST ENTOMOLOGY

Moderator: Bob Heller

Panelists: William Klein, Phil Weber, Wilmer Bailey, John Wear, William Ciesla

The objective of this panel is to examine the present status of remote sensing in both the application and research phases of the work. That is, we would like to examine what the various western regions are doing as represented by forest insect and disease control personnel. And also, we wish to look at the work being carried out by the research unit on remote sensing at the Pacific Southwest Forest and Range Experiment Station. You will notice that we have three representatives from the western regions and three from Berkeley.

Most of us are conversant with the term "remote sensing," but perhaps a little amplification is necessary. In a general sense, we are trying to identify objects (in our specific case, insect-affected trees) with instruments or techniques operated at some distance from the object. Most of our successful applications have dealt with aerial color and false-color photography, but we must not overlook the possibilities of using infrared line scanners, multispectral photography or multispectral scanners, or even radar. I think Phil Weber will touch on his work using optical-mechanical scanners for previsual detection of trees dying from attack by the mountain pine beetle.

In January 1971, one of the surprising outputs from the Western Bark Beetle Conference held in Placerville, California, was the importance of obtaining reliable impact surveys which measured not only tree loss, insect populations, and requirements for control operations, but also measured the loss to other resources such as watershed, recreation, or wildlife habitat. Remote sensing obviously should play an important role in helping to assess impact; an airborne view is the only way we can expect to cover our forest lands in a timely and expeditious manner.

Sampling Mountain Pine Beetle Damaged Lodgepole Pine with 35 mm Aerial Photography: William Klein

I appreciate this opportunity to tell you what we are doing with 35 mm aerial photography. Perhaps I should start by reviewing past accomplishments and then lead into present activities (slide 1). Those of you who attended the 1967 work conference in Las Vegas probably saw this contraption. It is a 35 mm stereo plotter invented by a Salt Lake geologist for photographic interpretation of geological maps. Knowing that this system for viewing 35 mm transparencies was available, and considering its potential, we began to take our own photography from our regular survey aircraft (slide 2). Coincident with

the picture taking, by necessity more than anything else, we developed a vibration dampening camera platform that attached to the window ledge (slide 3); a small pocket computer that told us scale, cycle interval, and format area with change in elevation (slide 4); and a small portable stereo viewer for viewing the transparencies in the field.

Our first attempts produced very small scales--in the neighborhood of 1:15,000 to 1:50,000--and although we were unable to see much detail we nonetheless accomplished our initial objectives (slide 5)--we developed the ability to take good quality 35 mm vertical stereo photography from a small aircraft. We also gained valuable experience with different lens, film, and filter combinations. In addition, we developed the ability to produce imagery in a scale of 1:4,000 without the assistance of an intervalometer or other electronic camera equipment (slide 6). One thing we did improve on was to take the camera inside of the aircraft by constructing this inexpensive camera hole in the baggage compartment. It cost $150.00, compared to $1,000.00, and possibly more, for a conventional camera hole, and did not require FAA approval for it did not impair the structural or flying characteristics of the aircraft.

By now, in addition to other uses, we needed to know if the system could be used as a tool to measure the impact of the mountain pine beetle on lodgepole pine stands. The mountain pine beetle is easily the most important forest insect problem in the intermountain region today (slide 7). As a start, in 1968, one area on the Bridger National Forest containing a mountain pine beetle epidemic, was photographed at three different altitudes to produce scales of 1:4,000, 1:6,000, and 1:8,000 (slide 8). The number of faded trees was counted by three untrained interpreters and an analysis made. Photo counts approached ground truth with each increase in scale, but the mean difference was not significant. On this basis, then, we decided that 35 mm aerial photography showed promise as a potential sampling technique but a more comprehensive and thorough analysis was needed before it could be used on an operational basis.

(Slide 9) in late August of 1970, two areas containing relatively heavy mountain pine beetle activity on the Caribou National Forest and in Grand Teton National Park were photographed at a scale of 1:5,000. An attempt was made to photograph a variety of stands and conditions, i.e., (slide 10) pure stands versus (slide 11) mixed stands, and (slide 12) dense versus (slide 13) open. Film was Kodacolor-X, a color negative film, from which 3x5 inch prints were made (slide 14). Nineteen plots ranging in size from 0.3 to 4.0 acres were deliminited on the photos and examined on the ground. All dead trees over 8 inches d.b.h. were measured (d.b.h.) and recorded. The trees were classified as to (1) new faders (1969 attacks) and (2) old faders and snags (1968 attacks and before). Density of total mortality on all plots averaged 36 trees per acre. There was a total of 669 trees in the exercise (slide 15). Photo interpretations were made from 3x5 prints with the aid of a pocket steroscope. There were five interpreters, none having any practical

experience in photo interpretation of this type. One interpreter, in fact, was a laboratory technician who had never seen a faded lodgepole pine first hand. Training involved a short photo exercise showing several trees in various stages of decline (slide 16). The main objective of the exercise was to detect and record all mortality in each plot. As an adjunct, each observer was asked to separate the new faders (1969 attacks) from all other mortality.

The preliminary analysis of data entailed computing a regression line and corresponding r^2 value for each observer (slide 17). Here, for example, are regression lines and r^2 values for each observer which show their relative ability to discern new faders. The dashed black line is Y=X, or a perfect correlation between photo and ground counts. All correlation coefficients, r, are highly significant and most important, with one exception, the r^2 values show that more than 95 percent of the variance of the photo counts (Y) is associated with the ground counts (X). The one maverick (green line) was caused by an observer who detected the dead trees on one plot accurately, but could not separate them as to degree of fading. It is important to know that this type of error can be made, but I honestly feel that it could be easily corrected with very little training (slide 18). The relationship of photo counts of old faders and snags with ground truth also shows strong correlations but not quite as strong as with the new faders. The r^2 value of our green observer has improved considerably but was still affected by previous misinterpretation. It is interesting that although he came closer to the actual number than the other four interpreters, he still had the lowest r^2 value (slide 19).

All five interpreters were able to detect total mortality with a high degree of consistency which is reflected in part by the highly significant r^2 values, the lowest being 0.96. Rather interesting, the interpreter with the highest r^2 values and lowest standard deviations from regression for the three categories was our female laboratory technician.

In summary, then, this exercise showed that 35 mm color aerial photography has potential as an inexpensive and highly efficient sampling method for measuring the impact of the mountain pine beetle. In addition, the potential of the system assumes even greater significance when you consider the fact that lodgepole pine is not only our smallest conifer; but, it also grows under relatively dense conditions (slide 20). We hope to continue this project in 1971 by double sampling stands depleted by the mountain pine beetle in specific areas on the Targhee and Teton National Forests.

Thermal and Multispectral Studies in Connection With the Black Hills Beetle: Phil Weber

The need to develop an efficient, reliable previsual[1/] method of detecting forests under stress from insect attack is shown by the huge losses from forest disturbances in the United States. Recurrent losses from epidemics of the mountain pine beetle (Dendroctonus ponderosae Hopk.) in the Black Hills have persisted for years. Finding attacked trees had traditionally been done by a combination of aerial sketchmapping and an accurate ground sampling design. Only recently aerial color photography in connection with an accurate multistage sampling survey have updated reconnaissance techniques which have been used for 10-12 years.

Photography as a remote sensor is in practice limited to the spectral range 0.4 to 0.9 micrometers (μm). Although this spectral range now provides most of the information used by forest managers and entomologists, photography is limited to locating infested trees after the foliage has visually faded. In the Black Hills the faded condition is frequently seen shortly before or often after adult beetle emergence; thus, some forest managers are understandably reluctant to use aerial methods as a detection tool for control purposes.

Since 1964, we have investigated the applications of airborne multispectral remote sensing and the potential of automatic multispectral processing for detection and classification of stress in ponderosa pine caused by bark beetle attacks. Optical-mechanical line scanners are flown over our research site in the Black Hills which resulted in our obtaining imagery at several different altitudes and at many different times of day recorded in 18 discrete wavelength channels between 0.4 and 13.5 μm. Multiple-channel processing of registered data was achieved in two spectral bands (.4-1.0 μm and 1.0-5.5 μm), and specialized single-channel processing was used for thermal infrared data in the 8-14 μm wavelength band.

In testing the multispectral concept of stress identification using ten of the best twelve airborne spectrometer channels (.4-1.0 μm), which were judged to contribute most to the identification of stress, we have used three classification problems: the first, a generalized forest type classification; the second, classifying three conditions of tree vigor in ponderosa pine; and third, identifying nonfaded bark beetle-attacked ponderosa pine. Using hybrid analog and digital multispectral recognition techniques, we have obtained an adequate classification for the first two problems. However, on the last and most difficult problem of identifying green beetle-attacked trees the probability of misclassification was high. This mediocre performance, using all 10 available registered channels, attests to the difficulty of the problem in using visible and photographic (near) infrared data.

1/ Previsual detection is defined as location of stressed trees by some remote sensing media prior to the time that they can be detected on large-scale (1:2,000) aerial color or color infrared photography.

A recent contribution was derived from processing efforts with 3-channel infrared data (1.0-1.4 µm, 2.0-2.6 µm, and 4.5-5.5 µm). In the past classification errors were made in identifying tree vigor when only visible and near infrared spectral channels were used. It is apparent now that it would be beneficial to extend the spectral range of the present airborne spectrometer into the thermal infrared. We found that data in the wavelength band 2.0-2.6 µm, when added to the existing channels, reduced classification errors significantly. This was particularly true with early morning data.

Successful thermal separations were made on single-channel thermal infrared data in the wavelength band 8.2-13.5 µm. Foliage on the green-attacked pine were only a few degrees warmer than the foliage of healthy trees; this difference suggests that attacked trees are thermally masked, frequently by radiance variation of healthy trees—a finding substantiated by ground data. For example, conifers have been separated on five discrete thermal levels with an apparent temperature spread of only 3.5°C. A complication with the interpretation of thermal responses in forests is that terrain objects are detected on more than one thermal step, largely because of variations in slope and target aspect. For example, conifers in the same condition class on different slopes are revealed in several different steps. This phenomenon is actually the result of irregular irradiance of all points within the instantaneous field of view of the airborne scanner.

As of now there is no operational program for the implementation of multispectral detection of stress in forests with airborne optical-mechanical line scanners. Although great strides have been made in the development of detection and interpretation techniques, there are as yet some unresolved problems related to detection accuracy and operational cost.

We feel the potential for improved results will be achieved when multispectral scanners become available which provide for a common field stop for all channels, or at least a common instantaneous field of view in the visible, near infrared, and thermal infrared regions. As we see it the greatest and most direct benefit to forest biologists from an improved multispectral system will be the pre-visual detection of stress in bark beetle-infested trees. Although we have shown some detection success working independently with each of three spectral bandwidths, the availability of simultaneously registered data covering the entire bandwidth in narrowband increments should yield large improvements in accuracy of stress detection.

Aerial Surveys and Photography in Colorado, Wyoming and South Dakota: Wilmer Bailey

Surveys in Region 2 are conducted primarily in twin-engine aircraft of the Cessna Skymaster series. I have found this particular aircraft to be specially suited for mountainous flying during the summer where slow flying is required. This type of aircraft has shown a high degree of reliability and stability for sketchmapping and hand-held photography. In taking aerial photographs of insect infestations, I have used a Hasselblad 500 type camera with Ektacolor film. I can send this film out and get color prints made in a short period of time. In 1971, I hope to be able to establish a small darkroom processing facility at our regional offices. Thus, we may have more ready access to the color films and more control over the processing.

I have taken Polaroid color aerial photographs and found them to be quite useful at the time they are taken. Although they are fixed immediately, one must be careful to keep them out of direct sunlight because they fade quite rapidly. If the photos are taken over an infested area and given to the ground crews the next day, they have been found to be very useful. The implications of using Polaroid color film need not be amplified further.

I expect we will continue to make sketchmapping surveys and examine Region 2 territories by that old reliable sensor--the eye--and use aerial color photography when the infestations become many and large in size.

Mountain Pine Beetle Survey in Lodgepole Pine in Washington: John Wear

Forest managers are frequently faced with serious forest insect problems such as epidemic bark beetle outbreaks. Before salvage or control operations can be initiated, data are required on the distribution and intensity of insect damage on environmental and biological factors for the forest community and the insect buildup, on local economics and conditions of the lumber market, and on the various factors affecting efficient logging operations.

Aerial color infrared photography was taken of the 112,000 acres of mountain pine beetle-infested lodgepole pine in eastern Oregon. Color infrared (CIR) photography and double sampling with regression have provided bark beetle impact data, trend information of the infestations (ground survey data from the double sample), orientation of logging roads based on mortality distribution patterns and surrounding timber resources, and orientation of field work to make forest environmental and insect biological evaluations. Data from the double sampling system were collected on the 11 forest blocks in less time and at lower cost than a straight field survey of comparable accuracy. Use of color infrared photography will continue

to help in planning and conducting the many phases of the salvage and control operation.

CIR photography should be taken of these same areas again in 1971, as well as adjacent areas into which the infestations have spread so that reevaluations of the bark beetle outbreak areas can be made to establish salvage-control priorities. It is further recommended that photo scale be changed to 1:8,000 (or obtain 9X stereo capabilities) so that a direct photo-volume PI system can be used to improve volume estimates and reduce sampling error.

This project is a good example of how color photography has become accepted as a management tool in solving both old and new forestry problems.

Status of Remote Sensing in the South and Plans for Region 1: William Ciesla

The Division of Forest Pest Control of the Southeastern Area entered the "remote sensing" era in 1964 when C. E. Cordell, plant pathologist at Asheville, obtained some color and false color photography of several important forest insects and diseases. His primary objective was to detect previsual symptoms of disease infection and bark beetle infestation. With the exception of one annosus infected eastern white pine, he was unable to detect previsual symptoms but his early work laid the groundwork for further interest and work in the use of color aerial photography for forest insect surveys.

In 1965, we combined color aerial photography with an operation recorder survey design. The methodology has been described rather fully in a publication recently issued by the Southeastern Area. Nothing further needs to be said about this method other than to fully utilize it, we had to develop remote sensing capabilities at each of our two field offices. This capability enabled us to explore quite readily the use of color aerial photography for other forest insects and diseases as well as some other rather diverse subject matter. During the 3-1/2 years I was at Alexandria we received requests to participate in underflights, for the Apollo 9 mission, obtain photography for recreation site planning, and evaluation of herbicides for timber stand improvement on National Forest lands, and on one occasion, assisted the Texas Fish and Game Commission in estimating the size of the pronghorn antelope herd in west Texas. Today I want to briefly discuss some of the work we've done with insects other than the southern pine beetle.

In August 1969, Hurricane Camille struck the coast of Mississippi, causing varying degrees of timber damage over 1.9 million acres. In addition to the immediate loss caused by the storm, large numbers of windthrown trees created conditions favorable for a massive buildup of Ips engraver beetles. By October 1969, our worst fears were

realized. Engraver beetles had emerged from windthrown material and invaded large numbers of standing trees in the vicinity of Bay St. Louis and Pass Christian, Mississippi. We received a request from the Mississippi Forestry Commission to survey these areas in March 1970. A double sampling with regression survey design was used for an aerial photo survey of approximately 34 M acres. Dead trees were counted on 25-acre plots superimposed on color aerial photos taken at a scale of 1:4,000. A small subsample of the aerial photo plots were ground checked. This survey provided estimates of the number of trees killed by *Ips* and pulpwood and sawtimber volume losses in areas of heaviest *Ips* activity.

The forest tent caterpillar has been at epidemic levels for many years in the bottomland hardwood forests of southwestern Alabama and southern Louisiana. The hardwood research project of the Southern Forest Experiment Station has been engaged in the evaluation of non-persistent chemicals in ULV dosages for the control of this insect. During April 1970, ten 40-acre plots were treated with different chemicals. Poor drainage and lack of access made detailed evaluations of the effectiveness of these materials almost impossible. We assisted the research entomologists by obtaining color aerial photography of the spray plots. Two films--color and false color--and two photo scales--1:6,000 and 1:15,000--were used to measure the amount of foliage retained on the spray plots in comparison with surrounding stands. The small scale (1:15,000) false color photography did the best job.

The loblolly pine sawfly, *Neodiprion taedae linearis*, was at epidemic levels in Arkansas, Louisiana, Mississippi, and Tennessee during 1970. This provided us the opportunity of comparing paired aerial photos of pine sawfly defoliation in color and false color film. Defoliation was considerably more conspicuous on the false color film. This plus the ability of false color film to separate hardwoods from conifers makes it an excellent means of mapping sawfly defoliation.

Some limited work has been done in Region 1 on the use of color aerial photography for insect and disease detection and evaluation. Attempts have been made to evaluate damage caused by larch casebearer defoliation and to map injury to forested areas caused by fluoride emissions. Plans are presently being formulated to take existing research information and improve survey methods for some of our major insect pests using color aerial photography. These include Douglas-fir beetle, mountain pine beetle, and larch casebearer.

Remote Sensing Studies at PSW Forest and Range Experiment Station, Berkeley: Bob Heller

At Berkeley, on our remote sensing project, we are working on multi-disciplinary studies. For example, we have studies under way with forest survey. We have done some work with space photography as it relates to forest inventory. We are working closely with forest disease research on air pollution studies in southern California, where smog is inducing loss of vigor and mortality to ponderosa pine, and in Southeastern United States where sulphur dioxide is causing loss of growth and mortality to Virginia and loblolly pine. Still, our main source of funding and the bulk of our studies deal with forest insect problems. We have had studies on the spruce bud-worm in Minnesota, tussock moth in northeastern California, western pine beetle in California, and mountain pine beetle in South Dakota.

In connection with our mountain pine beetle studies in the Black Hills with William F. McCambridge of the Rocky Mountain Station, we have found some interesting results as follows: (1) rate of fading--we determined that in the Black Hills trees in the same stand fade at differential rates even with similar levels of attacking adults, larval populations, or the amount of blue stain present. We found that the use of Munsell color cards provides a reliable index of tree color which can be related from ground observations to the large-scale aerial photographs. We also found that the Munsell ground read-ings related best to the vertical aerial photographs but not very well to pictures taken of the fading trees with ground cameras, (2) sur-vival of attacked trees--in three years of studying 11 separate in-festations each year, we found that about 20 percent of all attacked trees, with good brood development and sawdust in the bark crevices, survived the attack, (3) comparison of color and false-color films--in the Black Hills we could establish no difference in interpretation accuracies in using color or false-color film regardless of season or scale of photography. The scales ranged from 1:1,600 to 1:174,000, (4) survey designs--interpretation accuracies on color or false-color film were very good on infestations larger than 4 trees or averaging 20 feet in diameter when scales were as small as 1:32,000. While this scale of photography will not permit us to detect beginning in-festations, it does provide us with a tool to design more efficient sampling surveys. For example, we can photograph a large area in its entirety at a scale of 1:32,000 and select areas to subsample more efficiently at large scale. Of course in the end one uses the large-scale photographs to sample the ground locations for tree volume and our green infested trees. Probability sampling surveys appear to be one of the most efficient ways of measuring bark beetle populations as well as estimating loss of timber volume from the aerial photo-graphs. When properly designed and executed, surveys of Douglas-fir beetle losses in northwestern California, mountain pine beetle in the Black Hills, and timber volume estimates made from space photographs in Southeastern United States illustrate the efficiency of the design, (5) clustering and randomness of beetle infestations--we are plotting

all infestations occurring on a 1x3-mile area in the Black Hills over a 4-year period. This is the area of epidemic conditions with no control effort being expended. The following beetle infestations is also being done on Bureau of Land Management lands in the Black Hills where extensive control efforts are being made. Finally, the impact of the insect pheromone on the western pine beetle-affected trees is being followed by aerial color photography at Bass Lake. Again, the trend of the infestations is being plotted and followed from the sequential aerial color photographs. We hope to learn more about the most efficient survey designs for taking aerial photographs and for making ground surveys for green infested trees from these studies.

The remote sensing project at Berkeley is also working on ways in which we may be able to use space imagery most effectively. I mentioned earlier that R. C. Aldrich was able to separate pine from pine hardwood and bottomland hardwood on pictures taken by the Apollo 9 astronauts in Mississippi and Georgia. We hope to tie in these studies with forest survey estimates of forest land change, trends in mortality, and losses from insects and disease. We are proposing to NASA that we obtain satellite imagery from them over the Black Hills and also over the Targhee-Teton area to learn whether we can pick up these massive infestations on the low-resolution imagery which they expect to obtain from their Earth Resources Technology Satellite. The satellite will be put into a 600-nautical-mile polar orbit of the earth in March 1972. We can expect to get images of the same location every 18 days; it is possible that the very large infestations will show up on this imagery. About one year later, in 1973, NASA will launch a manned satellite called SKYLAB which will obtain imagery with much better resolution. We should be able to tell something about the usefulness of space imagery from these experiments.

PANEL: GRADUATE STUDENT PROBLEM SELECTION PROCESS--IS THERE A NEED TO ESTABLISH REGIONAL AND NATIONAL PROBLEM PRIORITIES?

Moderator: Ron Stark

Stark reports a stimulating discussion was had by all.

POTPOURRI

Moderator: Dick Washburn

1. New Insect-Host Relationships

Pinyon Needle Scale in California: B. Roettgering
(Summary not submitted)

A Pine Looper in Ponderosa Pine: J. Dewey

Jed Dewey, Region 1, gave a 35 mm slide presentation on the damage and life history of a looper, Phaeoura mexicanaria (Grote). This insect defoliated over 25,000 acres of ponderosa pine in 1969 and 60,000 acres in 1970 in southeastern Montana. Defoliation ranged from light to complete denuding of the trees. All stand types and age classes were attacked. Most severe damage was inflicted along ridges or benches. Defoliation predisposed many of the trees to attack by Ips calligraphus (German). By the end of August 1971 the looper population had completely collapsed due to a bacterial disease. This was the first report of this insect ever causing damage as well as a new state record.

2. Impact of Shelterbelt Insects in Canada and United States

Impact of Shelterbelt Insects in Manitoba and Saskatchewan: Bill Ives

The effects on shelterbelts in Manitoba and Saskatchewan of attacks by the more important insect pests are discussed briefly for each species. Insect attack sometimes causes death of all or part of the tree, depending on the nature and severity of attack, but more often causes weakening or disfiguration.

The most important foliage pests on deciduous trees are the loopers, especially cankerworms on Manitoba maple, elms and basswood. Other major pests are the poplar-bud gall mite and a leaf mining beetle (Zeugophora sp.) on hybrid poplars, aphids on a variety of hosts, and occasionally spiny elm caterpillars and leaf beetles on elms, maples and hybrid poplars. Borers are a problem on a variety of hosts. The two most important are the boxelder twig-borer, attacking Manitoba maple, and Saperda sp. attacking plantings of poplar and willow.

Coniferous trees generally have fewer insect problems than deciduous trees. Pine needle scale is an important pest on pines and spruces, especially if left unchecked. Spruce spider mite is also important, particularly during hot dry weather. Spruce is also attacked by several species of sawflies, the most destructive being the yellow-headed spruce sawfly. Other spruce pests include gall-forming aphids and needle miners.

A brief discussion of insect outbreaks in shelterbelts during 1970 is given. No major problems were encountered, but nearly all of the above species caused significant damage somewhere in the area.

Impact of Shelterbelt Insects in the United States: John Stein

The area of the Great Plains approximates 700,000 square miles. At the present time, the shelterbelt entomology project located at Bottineau, North Dakota, is a two man project covering the Great Plains area within the jurisdiction of the Rocky Mountain Forest and Range Experiment Station.

Green ash is one of our most versatile trees used in shelterbelt plantings. However, its planting has been curtailed in the western half of both North and South Dakota by the ash borer and the carpenterworm. The boxelder twig borer has contributed to the deletion of boxelder in field plantings during the past ten years.

The western pine tip moth, Zimmerman pine tip moth, and the pine pitch nodule maker infest ponderosa and Scotch pines in nurseries and windbreak plantings. Many defoliators included among potential pests are: elm spanworm, spring cankerworm, fall cankerworm, fall webworm, elm sawfly, yellow headed spruce sawfly, and the elm leaf beetle.

Between 1963-1965, surveys indicated that the woolly elm aphid, poplar petiole gall aphid, and the boxelder leaf gall were among the eight most prevalent pest species encountered in North Dakota shelterbelts.

3. Park Service Insect Control Problems Due to Chemical Restrictions

Canadian National Parks Insect Control Problems Due to Chemical Restrictions: Les Safranyik

With the exception of the spruce budworm outbreak in Fundy National Park that began in 1969, insect activity in the forests of Canadian National Parks during the past two decades were generally low to require control. Consequently, there has been little experience in evaluating what control problems, if any, would arise from the recent restrictions imposed on the use of pesticides by the federal government and/or from restrictions inherent in National Parks Policy.

The National Parks Policy provides only general guidelines regarding the protection of park forests from unacceptable losses caused by insects. Each insect problem is examined by park officials as they arise and the need for control, the control

method, the duration and spatial extent of control operations will be decided upon by considering the type and intensity of insect activity, its impact on National Parks values, type of use of the park or section of park affected, and the possibility of the infestation spreading to adjacent commercial timber lands. The following example will help to illuminate how forest insect control decisions are affected by consideration of park values. A large area of dead timber from a forest insect infestation might be acceptable in large wilderness areas but might be quite unacceptable in special ecological areas, in areas containing a high level of visitor use facilities or in areas which are predominantly used for recreational purposes and in which the obligation to preserve the natural state is strictly secondary.

In determining the intensity, spatial extent, the rate of spread of the infestation, and the possible methods of control, park officials are advised by specialists from the Department of Fisheries and Forestry and the Canadian Wildlife Service. In general, when park administration is satisfied that control action is necessary, chemical control of the insect pest will be considered only when no satisfactory non-chemical techniques exist. No chemicals will be used where there is a belief that water and air quality will be degraded and hazards will exist that threaten fish, wildlife, their food chain or other components of the natural environment. The type of chemical used is subject to the following federal restrictions:

a. The insecticide used must be registered for use in Canada against the target insect, and

b. Minimum strength and frequency of application, that will give satisfactory control, will be aimed at.

The spraying program to control an epidemic level of spruce budworm population in Fundy National Park is a recent example of chemical use in the forests' national parks. The spray program was initiated during the summer of 1970 because park officials were satisfied that if no control action was taken the infested areas of this park would serve as a reservoir for high budworm populations that would present increasing hazard to the mature spruce-balsam forests of the park and the adjacent commercial timber lands. In 1970, 30,000 acres were sprayed with Fenithrothion--an organo-phosphate--at a concentration of 1/8 lb. per acre in two applications. The control program calls for re-spraying the same area in 1971. Scientists from the Canadian Wildlife Service and the Department of Fisheries monitored the spraying in 1970 and so far did not observe any damage to fish and bird populations.

Park Service Insect Control Problems in U.S. National Parks:
Es Lampi

Use of chemical pesticides have been placed under restriction by the Department of Interior. These restrictions apply to all department land managing agencies. Accordingly, the National Park Service will:

a. Conform with all provisions of Federal and State pesticide laws.

b. Not use chemicals on the departmental prohibited list.

c. Use chemicals on the departments restricted list only when:

   non-chemical techniques have been considered and found inadequate, and use can be limited to small-scale applications.

d. Use of any chemical pesticide must be aimed at a specific pest problem.

e. No pesticide will be used where there is basis for belief that:

   water quality will be degraded; hazards exist that will unnecessarily threaten fish, wildlife, their food chain, or other components of the natural environment.

f. Large-scale non-specific applications will not be made.

Departmental restrictions on the use of insecticides does not change National Park Service resource management responsibilities to protect forest vegetation from damaging insect attacks. Understandably, there is need to determine the difference between processes which insect populations represent in a commercial forest and insect conditions, endemic and epidemic, which represent a state of naturalness in a national park.

National Park Service policy on forest insect and disease control considers that under natural conditions forest insects are natural elements of the ecosystem. Accordingly, populations of native insects, and also the incidence of native diseases, will be allowed to function unimpeded, except when control is required (1) to prevent loss of the host from the ecosystem; (2) to prevent the complete alteration of an environment which is expected to be preserved; (3) to prevent outbreaks of the insect or disease from spreading to forests or trees outside the area; (4) to preserve rare, scientifically valuable, or specimen trees, or unique forest communities; (5) to maintain a suitable

overstory, shade, or ornamental trees in the vicinity of developed areas, and (6) preserve trees significant to the maintenance of historical integrity. Where non-native insects have become established or threaten to invade an area, of course appropriate measures should be taken to control the pest.

The Departmental prohibitions and restrictions on the use of environmentally damaging pesticides has not been unduly restrictive on forest pest control programs in the National Park Service. Area managers are now required to review alternatives and select insect control methods and/or mediumsthat conform to Departmental restrictions and service requirements. We are hopeful that these requirements will bring a greater awareness of National Park Service management objectives to all of our coworkers attending this work conference.

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4. Current Research in Scolytid Taxonomy: S. L. Wood

Greater activity in taxonomic research on American bark and ambrosia beetles is in progress than ever before in history. A much needed re-assessment of the genus Ips by G. N. Lanier is in progress; two parts were published in the 1970 Canadian Entomologist and others are expected to follow. The genus Pityophthorus and related genera are being reviewed by Bright. A comprehensive taxonomic monograph of the family Scolytidae for all of North and Central America is being prepared by S. L. Wood; this study is now 40 percent complete and should be published in 1975. As part of this latter study a bibliography of all literature treating all bark and ambrosia beetle species for the world is being assembled. It would be most helpful if forest entomologists would send reprints of all current articles they publish treating bark and ambrosia beetles (Scolytidae and Platypodidae) directly or indirectly in any way to S. L. Wood, Department of Zoology, Brigham Young University, Provo, Utah 84601.

PANEL: THE USE OF INSECT HORMONES AND THEIR ANALOGS IN THE STUDY AND CONTROL OF FOREST INSECTS

Moderator: John H. Borden

Panelists: G. B. Staal, T. S. Sahota, C. E. Richmond, J. H. Borden

This panel was arranged for two general purposes: (1) To summarize for forest entomologists the present status of research on insect hormones and their possibilities in insect control. This objective was assigned to Dr. G. B. Staal, Director of Biological Research for the Zoecon Corporation, and (2) To introduce forest entomologists to the limited but exciting current research on hormones in forest insects. Brief descriptions of their research were provided by three forest entomologists, Dr. T. S. Sahota, Canada Department of Fisheries and Forestry Research Laboratory, Victoria, B.C.; Mr. C. E. Richmond, Pacific Southwest Forest and Range Experiment Station, Berkeley, California; and Dr. J. H. Borden, Simon Fraser University, Burnaby, B.C.

The Present Status of the Development of Insect Hormones and Analogs for Insect Control: G. B. Staal

Dr. Staal presented a comprehensive review of past work on insect hormones, particularly juvenile hormone (JH) and its analogs. For practical purposes, he dismissed brain hormone because of its chemical complexity (probably a polypeptide) and because its effect can be mimicked by JH or the growth and moulting hormone (MH). Similarly practical application of MH is unlikely because it is difficult to apply, is very expensive to synthesize and could meet with problems when assessed by environmental protection agencies.

The outlook for the use of JH is somewhat brighter due to its lipid nature which enhances penetration through insect cuticle, and its often spectacular effect in disrupting insect development. It or its analogs are relatively persistent, there is minimal toxicity to warm-blooded animals and there are indications that certain analogs may prove to be specific to certain taxa (as is the case with juvabione). In addition, recent work may provide useful methods and application. There is some promise that JH may be used as a sterilizing agent, vapors of certain analogs and microencapsulation may provide effective means of application, and the search for antihormones could provide new and effective materials. On the other hand deficiencies include the inability to prevent damage by larvae in many cases, the possible effect of nonspecific compounds on non-target insects, the as yet unknown environmental impact of persistent agents, and the high cost of development which may necessitate that such work be done by governmental agencies.

Practical application in the near future would be most feasible in the following situations: (1) Where the larvae do no damage and delay in effect would be inconsequential e.g. in the control of mosquito larvae, (2) On insects with a short life cycle which includes a highly sensitive and susceptible stage, (3) In protected environments where compounds are not subjected to breakdown from solar radiation, and (4) In situations where stringent regulations are unnecessary.

The Role of Hormones in the Reproductive Physiology of Bark Beetles: T. S. Sahota

Dr. Sahota described some of the results of his work on the effects of a juvenile hormone analog, Farnesyl methyl ether (FME) on the Douglas-fir beetle, *Dendroctonus pseudotsugae*. In nature, the ovaries develop in female beetles within four days after they attack a fresh host. Application of FME induced significant ovarian development in beetles held on moist glass paper at room temperature and even more pronounced development if beetles were allowed to feed previously on bark chips, the metabolites from feeding apparently being used in ovarian development, even though ovarian development did not occur without FME application. Since protease activity was high in beetles allowed to feed on bark chips, even before FME application, JH apparently does operate by enabling the insect to break down injested proteins. A search for alternative mechanisms of JH activity led to the discovery that in female beetles allowed to attack host logs (not bark chips), two female-specific proteins are synthesized. They appear first in the hemolymph and then in the developing oocyctes. In beetles maintained on bark chips there are female-specific proteins in only small quantities. After applications of FME to these beetles there was a significant increase in the female specific proteins in the hemolymph, and in addition they were also found in high quantities in the ovaries. Thus it appears that JH has two functions: (1) It increases the rate of synthesis of female-specific proteins and their release into the hemolymph, and (2) It increases the rate of deposition of these proteins into the developing oocytes.

Effects of Some Juvenile Hormone Analogs on the Western Spruce Budworm, *Choristoneura occidentalis*: C. E. Richmond

Four compounds were tested by Mr. Richmond on the western spruce budworm in an attempt to study the effects of these materials on growth, development and reproduction. The purpose was to test the feasibility of using juvenile hormone analogues as control agents.

The effects of these compounds varied with the potency of the compound and with the amount applied. At light dosages the effects were primarily on reproduction, causing decreased egg production

and decreased hatch. The larger dosages resulted in increasing degrees of morphogenic juvenilization. Some of the more potent materials caused the induction of extra larval instars.

Many more questions need to be answered before juvenile hormone analogs are considered for the control of _C. occidentalis._

Summary of the Known Effects of 10-11-Epoxyfarnesenic Acid Methyl Ester on _Ips paraconfusus_ and _Trypodendron lineatum_: J. H. Borden

Dr. Borden summarized the results of investigations based on the hypothesis that juvenile hormone controls the behavioral and physiological changes which occur in scolytids when they attack their host and enter the reproductive phase. A JH analog, 10, 11-epoxyfarnesenic acid ethyl ester (EFA) was used in all test, with a standard topical dose of µg on _I. paraconfusus_ and 50 µg on _T. lineatum._

With _I. paraconfusus,_ EFA induced males to produce sex pheromone, caused degeneration of the flight muscles and rendered the insects unable to take off and fly. However, it apparently did not reduce the inclination to respond to flight-inducing stimuli, and had no effect on pheromone or light response, even though both of these responses are greatly reduced in beetles excised from host bark. Within one hour after EFA treatment to both sexes, _T. lineatum_ mating activity was completely inhibited, and remained so for at least 24 hours.

Two tentative conclusions were reached. 1. JH effects seem to be associated with physiological phenomena directly concerned with reproductive activity, e.g. pheromone production and flight muscle degeneration (which apparently is a prerequisite to ovarian development). Inhibition of copulatory activity in _T. lineatum_ would fit in this category if the effect of EFA treatment were to inhibit the production of a mating pheromone in females or to block appropriate sensory or motor activity in males. 2. Other behavioral changes such as the onset of indifferent or negative responses to pheromones or light must be associated with host stimuli or possibly internal stimuli produced following copulatory activity in the host.

WORKSHOP: TREE PHYSIOLOGY AND INSECT SURVIVAL

Moderator: L. Safranyik

This workshop was attended by 23 members. Discussion centered on insect attack and brood survival in relation to the physiological condition of the host tree.

Les Safranyik started by reminding those present that the workshop is not restricted to discussions of host effects on bark beetle populations and participants are free to discuss or present data on host effects relating to the establishment and survival of all injurious forest insects. Malcolm Shrimpton gave a summary of progress made during the past year on studies of resistance by lodgepole pine to the mountain pine beetle-bluestain fungi complex. Shrimpton's work to date indicates that resistance in lodgepole pine is due to an initial net synthesis of monoterpene hydrocarbon and a depletion in free sugars. Over a two-year period terpene, sugar and fatty acid levels decline, and resin acids and phenols increase, to heartwood levels. Inoculation of lodgepole pine trees of various ages with the bluestain fungus Europhium clavigerum to study relative resistance as a function of age yielded an unexpected result. The relative resistance of the sample trees increased with age up to 40-60 years, and then declined at progressively greater rates in the older age classes. In this experiment resistance was measured by the size of the resinous reaction that was apparent after two weeks following inoculation of the trees by the bluestain fungi. This experiment will be repeated with replications over the growing season on various sites.

In discussions following Shrimpton's presentation, it was emphasized that resin quality and quantity and their interaction are intimately related to the degree of resistance by host trees. Reference was made to work by R. H. Smith who showed that on host pines and host x non-host hybrids, where resin flow and attack density were comparable, monoterpene composition was important in determining attack success and gallery establishment by mountain pine western pine, and Jeffrey pine beetles. The western pine and mountain pine beetles were less successful attacking host x non-host hybrids than the same types of hybrids backcrossed to a host. Resin quality and quantity may be responsible for this difference. The timing of resin flow may also be important in reducing attack success and survival of certain bark beetles and shoot moths. For example, attack success by Scolytus ventralis on Abies grandis is determined by the rapidity of the host's resinous response, attacking beetles being repelled by resin flow. Resinosis occurring after brood establishment reduced survival. In relation to resinosis, the importance of the synchrony between the critical growth stage of the host and in relation to brood development has been emphasized. Reference was made here to the pine shoot moth (Evetria bouliana) which is rarely a serious pest in western Europe but it frequently ravages plantations in North America. Bud maturation

and development of resin canals in pine are relatively independent of summer temperatures and are, to a greater degree, responses to short days at the end of summer. Pine shoot moth development, on the other hand, is very temperature dependent. In North America more larvae survive in the summer to attack buds before there is well-developed resin protection. This early attack by the larvae accounts for the pest status of the shoot moth on this continent. Other examples were cited of the effects of resinosis and the moisture content of the phloem and outer sapwood of the host on attack success, egg laying hatching of the eggs, and brood survival of bark beetles.

Gene Amman summarized his and Walt Cole's work on the effects of phloem thickness on the population dynamics of the mountain pine beetle in lodgepole pine. He pointed out that differences in brood survival between trees with different d.b.h., and between stands of varying density can be explained, to a large extent, by differences in the phloem thickness of trees. In the discussions that followed, reference was made to the recent work of Hodges and Pickard who showed that there was a relation between the carbohydrate content of the inner bark of loblolly pines that were struck by lightning and the number of southern pine beetles emerging from these trees. The need was emphasized for more research into the effects of stress-induced changes in the metabolism of the host of the aggregation, attack success and brood survival of economically important bark beetles.

WORKSHOP: INSECT PESTS OF SHADE TREES AND ORNAMENTALS

Moderator: Wayne Brewer

Panelists: J. E. Coster, J. W. Dale, R. L. Evenson, H. E. Gray, W. M. Hantsbarger, D. M. Shrimpton, J. Stein, F. M. Stephen, H. E. Thompson, J. M. Wery

With increased interest in environmental pollution many changes are being made in pesticide regulation as it relates to ornamental plant pests.

In Colorado several legislative changes are presently being considered to deal with the problems associated with insect control on ornamentals. For example, an amendment to Colorado's Commercial Pesticide Applicators Act has been proposed that would prohibit the use of many pesticides on landscape plants. It would also limit the use of any pesticide to the pest and plant prescribed on the label. Secondly, a bill introduced to the Colorado Senate calls for the creation of a three man pesticide board with power to register or prohibit any pesticide in the state of Colorado. This bill would also require all wholesale and retail pesticide dealers to be licensed and that such dealers keep records of production, distribution, sales, and storage of pesticides.

The general consensus of the workshop was that far too much pesticide was being applied to ornamental areas. This was thought to be caused in part by many Commercial Pest Control Operators using a "route spray" system. These companies travel to contracted homeowners and spray the yard at several designated times during the year whether insects are present or not. A suggested alternative to the "route spray" system was to establish a pest control service whereby yards would be checked for pests on a schedule, but spray applications made only if pests were present. Such an alternative would probably reduce extensive, and frequently useless, pesticide application in landscape situations. It was pointed out that such a system would require skilled employees trained in insect detection rather than "spraymen" and would probably be met with considerable resistance by commercial spray operators.

The various states represented reported their means of regulating pesticides and pesticide applicators. The state regulatory systems ranged from almost none (Texas) to highly restrictive (Kansas). The consensus of the workshop seemed to be that regulation of pesticide users and applicators should be increased in most states.

The question "Is absolute control necessary in landscape situations?" brought a wide variety of responses. It was pointed out that in some cases, roses for example, absolute control was highly desirable because people did not want imperfect flowers or leaves. Some respondents noted that since the primary purpose of landscape planting was beautification, perhaps absolute control was necessary. The other point of view was that the environmental damage done by the pesticides could not be justified by a "perfect rose." It was also suggested that in many cases a 90 percent reduction in pesticide application could be made with control equal to that presently being obtained. The suggestion was made that many insects could be controlled in landscape plantings using cultural, mechanical or biological control methods. Also, many insect problems could be avoided by selecting plant varieties resistant to insect attack. Severe insect problems could be controlled using specifically directed chemicals. It was also noted that continual application of chemicals for insect control upsets the balance of natural control agents, thus increasing the need for chemical control.

The general view of the workshop was that there was a need for an intensive educational program for all levels of pesticide users, including the commercial spray operators, homeowners, and retailers. Various methods of educating these groups was discussed. For example, California has an Annual Garden Pest Clinic. Texas has used a comparable program for the past four years with considerable success. Kansas has the Kansas City Flower and Garden Show. All of these educational programs seem to be directed toward the public and effected through lectures, demonstrations, and individual consultation. Education of the commercial spray operator was mainly encouraged through licensing laws and requirements.

General Conclusions from the Workshop:

1. Several states are proposing legislation that will restrict the use of pesticides on ornamental plants.

2. There could be a considerable reduction in the amount of pesticides applied without reducing insect control if such application is made in an intelligent manner.

3. More use of cultural, biological, and mechanical control practices combined with resistant varieties of landscape plants could reduce insect problems without chemical controls.

4. Educational programs are desperately needed for all levels of pesticide users.

WORKSHOP: BIOCLIMATIC RISK CLASSIFICATION FOR DEFOLIATORS

Moderator: Roy Shepherd

The basis for prediction comes mainly from experience and historical records of stand conditions, topographic location and pre-outbreak weather. Knowledge on the effect of weather and stand conditions upon moth dispersal and egg laying and larval survival would also be helpful.

Criteria which may be useful for such a classification are:

1. Stand Condition - species composition; nature of the crown surface (density, closure, depth); relative amount of new foliage available (vigor, flowering, maturity); minimum stand size (dispersal relationships).

2. Local Climate - regional climate as determined by major land forms modified by local topographic features; temperature, humidity, cloud, rain and wind are modified by aspect, slope, and altitude for different air mass characteristics and direction of air flow.

3. Plant Communities - these represent the expressions of different ecological habitat as determined by stand and site conditions and local climate.

4. Current Weather - changes in local climates from year to year under different prevailing weather systems for critical periods.

5. Man's Activities - cutting, thinning, planting, fertilizing, etc.

Site conditions (Oregon) topographic position and weather (California and Alberta) were emphasized for the lodgepole needle miner, while weather seemed to be the factor most people thought would be useful for the blackheaded budworm and spruce budworm. Dwarf mistletoe has been found associated with certain plant or forest communities. Wellington's idea of local cloudiness was an indicator of degree of favorability was brought forward. Two of the critical questions which are hard to decide are: what weight can be placed upon the different criteria, and what size units should we be looking at in classifying a forest.

WORKSHOP: COMPLICATED CONTROL DECISIONS

Moderator: Paul E. Buffam

No doubt all future control decisions will be complicated. In many cases, we need better biological evaluations and impact data--both insect and environmental--upon which to base our decisions. We also need better economic data for cost-benefit evaluations. In the future, we will be basing our decisions on the effects of suppression on the total ecosystem instead of how many beetles or spruce budworm we can kill. These considerations will undoubtedly make our jobs more complex, but will help us accomplish our work in a more biologically and humanly sound way.

I have asked five people with varied backgrounds and from different geographical areas of work to report on their approach to solving present problems pertaining to making control decisions.

Problems of Control in the East: J. L. Rauschenberger

Comments were restricted to control of the southern pine beetle, <u>Dendroctonus frontalis</u> Zimm., the most destructive insect pest of pine forests in the southeast. As a multi-generation insect of high potential, infestations are characterized by sudden unpredictable changes from an almost nonexistant to epidemic status. The most effective and economical method of control is commercial salvage. The great degree of intermingled land ownerships in the east can complicate even this most simple control measure because of varying interest by land managers, different forest management plans, size of ownerships, and agreement on equitable stumpage value of infested material. The need for quick response to infestations through salvage and flooding of local markets compound the problems on single as well as intermingled land ownerships.

Other methods of control for southern pine beetle in the East include cut-pile-burn and chemical spraying of filled infested material. Presently these methods are used sparingly. Problems related to their use, especially that of chemical suppression, are the environmentally adverse effects as reflected in current state and federal legislation.

Fort Apache Spruce Beetle Infestation: Robert H. Frye

The spruce beetle outbreak on the Fort Apache Indian Reservation is a complicated situation for both Bureau of Indian Affairs and Forest Service personnel. The infested area is involved in a true "multiple use" function. The forested area is a major watershed for the state. Fishing and water recreation are major sources of income for the tribe. The high elevation streams are the home of the Apache trout, which is an endangered species. A new ski area is also situated in the infested spruce. Included in the infested area is the newly designated Mt. Baldy Wilderness Area, on the Apache National Forest. Any management decision, especially large clearcutting and/or chemical suppression, will be influenced by these factors.

Another major complication is the tribal sawmill which is managed by a corporation to obtain the most profit for the tribe. The sawmill uses primarily ponderosa pine timber because of its greater return. If salvage logging of spruce increases substantially, pine logging will be decreased, resulting in a decreased profit margin.

Another factor is that spruce is difficult to log and regenerate in the Southwest. Loggers do not have the proper equipment to harvest trees on steep slopes without doing extensive damage to the terrain. Also, areas logged in recent years have not regenerated satisfactorily because of lack of a cover crop and too wide of clearcuts--too great a distance from seed trees.

Mother nature may have saved us from this dilemma. In January 1971, record low temperatures occurred in the Southwest. This condition has apparently reduced the spruce beetle population below a treatable situation, so that suppression will be unnecessary. This means that the Bureau of Indian Affairs will not have to proceed on a crisis-management basis.

Problems Complicating Control Decisions in California: Robert W. Gustafson

In the first workshop Tuesday afternoon, bark beetle chemical control was the subject, but it soon went on to other bark beetle control methods including both prevention and suppression. I mentioned to Paul that this was encroaching on his workshop and that much of what I might have said was said. Paul suggested I show some slides anyhow.

In the following session, Oscar Schmunk spoke on Needs and Justification for Insect Control as Seen by the Colorado State Forest Service. He showed some excellent slides concerning the bark beetle control problems in urbanized forest areas. For some reason, I was naive enough to think that the great state of California was unique in this type of problem. However, we probably have had the problem the longest and perhaps the greatest. I guess all regions are getting into urbanized forest pest control, and gentlemen, we in California have empathy for you. At any rate, Oscar said many of the things I wanted to say and showed better slides to boot. In fact, I was tempted to ask for his script and slides and just change the key name of Colorado to California. I suggested this to Paul, but he said "well, show some slides anyhow."

It seems everyone is playing "show and tell" so I guess I'll do the same, although the short series of slides that I have hardly does justice to depicting the problems we face in making control decisions in California. Although, apparently, the problems in southern California are no longer unique I will still comment on them more than just casually. I don't have the exact figures as they keep changing every day, but it seems like there are "umpteen" million people in southern California and the number seems to increase every day. True, we lost a few a couple of weeks ago--some quite tragically and others just left from sheer fright.

We do have trees in southern California too--not as many as in the northern end of the State, but these somewhat small and remnant stands are quite valuable. We often refer to these trees as "people trees" as they are more valuable to look at, be under, and receive shade from than they are for lumber.

Ron Stark made the statement the other day that just like people, trees grow old and die and that we should educate the people to this and not spend money trying to save decadent trees that will ultimately die from one cause or another. This is true and we have been trying to educate the people, but a tree in one's backyard may be thought of as much as a member of the family and may even be compared to one on whom we may spend large sums of money through advanced medical science to prolong life even though we know for fact that an individual life must ultimately terminate.

At any rate, we have had bark beetle problems in southern California for years. Our strategy was to treat these trees in one manner or another as they became infested in hopes of reducing the bark beetle population or at least keeping it low enough to where tree loss was not too great. This is an old story that you are all familiar with.

In the control session the other day it was quickly brought out that the proper approach to control was to attack and remedy the condition that contributes to the outbreak. This condition in southern California was, of course, a decadent, overmature, high-insect-risk stand. From experience in northern California, through research and much actual application, we realized that we had to attack the bark beetle problem in southern California through a program of sanitation salvage. This, by now, is "old hat" to all of you, I know. However, I do want to reiterate some of the problems we faced in initiating such a program.

The first problem was to sell the public--or perhaps I should say educate the public--on the reasons for, and advantages of logging in these recreational forests. This happened almost 20 years ago--and it was quite a fight and chore even then. I hate to think of what our problems would be if we were just starting to educate these people today. Our educating didn't stop after the first successful sale. Each sale had its problems and oppositions. This education program still continues today.

Another problem encountered was the development of a market. Although there probably has always been a mill or two in the area since early day habitation, they were small pecker-wood operations set up for local use production. A relatively large mill and woods products plant was finally established in the area that had the capacity to handle the sanitation-salvage sales.

Anyhow, this method of control is working in the areas where it is feasible. All such areas have been logged at least once, and some areas twice. Thus, much of the area has been put under management even though such management may be somewhat extensive.

Bark beetles still cause us some problems but we try to handle them by salvage sale of infested timber or if this isn't feasible (usually because of current economics) we exercise chemical suppression methods. This combination of sanitation-salvage, supplemented with suppression, we refer to as "maintenance control."

There are other areas in southern California where we have been unable to log--again, largely due to long log hauls combined with tough logging conditions and poor quality timber. One of these areas is on Laguna Mountain of the Cleveland National Forest just north of the Mexican border. We have been unable to make a timber sale in this area.

Now, we know we should get rid of the high-risk trees, but with little or no means of utilization we can't very well cut these still-alive trees as we would in a timber sale, and just let them lay. This might be less costly in the long run, but it would be hard to justify to the forest users from the metropolitan area. So, realizing what we are doing, we cut and treat these trees each year as they succumb. Hopefully, the one we cut and treat will save one or two adjacent trees for a few years at least.

Is this control? Yes, we call it that--and it's done on a planned annual basis. Do we like it? No, we'd like to do something better. Do we believe in it? Yes, perhaps because at the present time we don't know anything better to do. We feel we are doing something--if just biding time until we can come up with a better solution.

The same thing is happening in other areas in southern California. I assisted in an evaluation last year and questioned the good of chemical control without stand conditioning. There was no reasonable hope of stand conditioning at that time, but chemical control, if done properly, could knock the population down to an endemic level and with proper weather conditions and the "the Good Lord willin'" we may not have to do any further suppression work for several years. (This area is not under maintenance control.) The land manager presented a cost-benefit analysis, based on esthetic and recreation use, that we were willing to accept--but with some reluctance. This type of control--or I should say suppression--decision is becoming more and more difficult to make.

In other areas in southern California--some that might be considered in the heart of our sanitation-salvage areas--we have other problems--still people problems, but real close people--homes, buildings, and other improvements. What do you do with a bug tree next to an $85,000 home? Well, in southern California you cut it down and treat it! Why? Because we are now committed to do it! Most of the work is done by the California Division of Forestry (we pay 25 percent, the landowner 25 percent, and the State the rest). The landowner pays his 25 percent through a special local tax so we may treat five trees on one lot, one tree on another, and none on the neighbor's lot--at least not this year. Thus, each homeowner pays an overall proportionate share each year whether or not any work is done on his land. These situtions are tough, but we're into them, they're legitimate, and they do an immediate suppression job, that is; they may save the adjacent tree on the neighbor's lot and prolong the life of other trees in the neighborhood. These trees are valuable. Lots market for an additional $2,000 or better if there are trees on them. This is what we are doing in southern California and a few other problem high-use areas. Some day maybe we can do better--I hope so.

Now all this is old stuff to most of you. Doc Hall is an expert on maintenance control and perhaps has told you this same story in a similar workshop 15-20 years ago when it was new. But we do have some new problems or complications now. See this faded tree? You may

think it's a bug tree, but it's not. You've problably heard of it as X-disease, Chlorotic decline or even in more earthy terminology as the Crestline crud. But no matter what you call it--it's just another people problem in the form of a dirty four-letter word--S-M-O-G--smog! If you were a bug spotter in southern California, you wouldn't find it easy! This is another problem to complicate our control decisions. I don't really know the full impact of this (maybe some do) but it's something that we are having to face up to and our maintenance control projects will have to seriously consider this in forthcoming evaluations.

OK--enough of southern California. Let's jump north where there are more trees, more mills, and fewer people (today but maybe not tomorrow). Here we have some different problems facing our control decisions. Our big push on suppression is logging infested trees! When the lumber market is up--great--"away we go." With effort we can sell most of the infested timber. If the market is down, we can't give it away. So--fluctuating timber markets are a problem, and why we may resort to chemical control.

(If time, cite the Jeffrey pine beetle problems on Lassen and Plumas)

Coming back to eduation--somehow we need to put across that bluestain lumber isn't all that bad. We've been trying to do this for years but we haven't made the grade. Maybe we need to hire an "umteen" thousand dollar a year publicity man because us "dirt foresters" and even wood products people haven't made the grade.

(If time, cite Cheney Grant and bluestain studies)

Well anyhow, let's get back to the cause of some of the bark beetle problems. One is stand density--we understand this and whether some of you realize it or not we are working on it. We are reasonably well up on it in our young stands as our thinning program is well underway. We can accomplish a lot for our dollar. Good! But our bark beetle problems (except maybe for Ips) are not in these stands. They are in our older second-growth stands where markets are only slowly developing in California.

Take McCloud Flats for instance. (Most everyone familiar with northern California knows of McCloud Flats and you'll be hearing even more of it in future Work Conferences, I'm sure.) We've been fighting the battle of the Flats for at least a decade and a half now--with three major sieges in my period of acquaintance. What's the cause? Overstocking! At least that's what we believe, and all our evaluations allude to this, but still we have continued to fight the beetles with chemicals and salvage. The last battle was entirely salvage but we still can't claim complete victory. We beat the enemy down, but we're still taking high endemic tree losses. Why? Well, that's another complicated control problem and it evolves around funding. We are reasonably well financed for detection and evaluation, but that just locates and identifies the problem. If the situation

warrants immediate suppression we are reasonably well funded for that too. But if the evaluation indicates "get at the cause," that prevention and for this funding we rely largely on other management activity money, such as timber sale and stand improvement funds. If the Forest service land manager could look at a dollar as a dollar our pest control problem would be lessened. But the way we operate (in accordance with the Congress and the Bureau of the Budget) pest control is often left "sucking hind tit" when it comes to accomplishing control through prevention. Now that's a pretty rash statement but that's how I recognize it. Also, I recognize that I, as a pest control specialist, and you, as entomologists have a selling job to get these dollars where they will do the most good in the long run. There is no question in my mind that funding problems complicate control decisions.

I would also like to mention the new service-wide timber sale contract. I wonder how many in Forest Pest Control (FPC) has any input in its preparation. I look at the contract as a potentially good tool for handling some of our control problems. We finally did have some input but it was too late and now can only be handled at a local level. Look over the contract carefully and see if you don't think that the way it is written it doesn't have some effect (possible adverse) on your control decisions.

We have faced tough control decisions in the past and in many cases are facing even tougher ones today--and I would venture to guess that the way things are going "you ain't seen nothin' yet!"

The European Pine Shoot Moth Problem in the Pacific Northwest: LeRoy N. Kline

The European pine shoot moth, Rhyacionia buoliana (Lepidoptera: Olethreutidae) has been one of the most controversial insects in the history of western forest entomology. It is undoubtedly a nuisance on ornamental pines in west-side communities, but its impact on native forest plantations is still unknown.

The insect was first introduced into Eastern United States from Europe in 1914, and has since deformed native pine plantations in that region. It was next found in British Columbia in 1927 and was believed to have been eradicated in that area. The next accidental discovery of the insect in the West was in 1959 in Seattle, Washington. Intensive surveys which began in 1960 and 1961 showed that most of the Puget Sound area was heavily infested. Eradication by host tree removal was not practical. One spot infestation was found in Spokane, Washington and was eradicated at that time. One spot infestation was also found in Portland, Oregon and eradicated. Surveys to date have found the insect every year in nurseries and ornamental plantings in Oregon and Washington. There is no known infestations in natural

stands. Surveys of ornamental plantings in both States have been done cooperatively by U.S. Forest Service, Washington Department of Natural Resources and Oregon Forestry Department. Surveys of commercial nurseries have been the responsibility of the respective State Agriculture Departments.

The first major control decision made was to eradicate the insect in Western North America when techniques become available. A containment zone and intra-state quarantine was established around the Puget Sound area in Washington. Oregon and other western states placed a quarantine on the State of Washington and would not accept shipments of pines unless certified clean through fumigation. These efforts were taken to reduce the spread of the insect from infested areas to uninfested ornamental plantings and native pine stands. Spot infestations, when found in ornamental trees, were destroyed by burning or by fumigation. Authority of such action was under the Department of Natural Resources in Washington and the Department of Agriculture in Oregon. Most of the research during this time was directed toward fumigation and the sterilized-male technique for eradication.

A re-evaluation and second complicated control decision was made in 1966 of the problem. It was decided at that time that complete eradication was not practical in Western North America because of high cost, length of time required, uncertainty of success, and hazard of re-infestation. Control by chemical sprays, spot eradication where possible, and containment was then the decision from 1966 to 1970.

In 1967 several communities in southeast Washington and northeast Oregon were found to be infested. Age of infestations varied from three to twelve years. Infestations in Walla Walla, Washington and Hermiston, Oregon was 15-20 and 40-50 air miles to native pine stands. Windbreaks consisting of uninfested pines around scattered farm houses existed between the communities and native pines. One of the infestation areas (McNary Dam, Oregon) was reserved for research by the Pacific Northwest Forest and Range Experiment Station. Eradication by host tree destruction was not practical because of the number of pines involved. A decision to control by chemical spraying was made. Authority for control in Washington was under the Department of Natural Resources, whereas the authority in Oregon was under the Department of Agriculture. The Department of Natural Resources and Oregon Forestry Department supervised the spray projects in the respective states with technical and financial assistance from the U.S. Forest Service.

Chemical sprays were applied to the southeast Washington and northeast Oregon infestations in 1968 and 1969. A small infestation in south Portland was also sprayed in the summer of 1969.

Out-planting tests under strict quarantine conductions were made by the Pacific Northwest Forest and Range Experiment Station during the summers of 1968 and 1969 in east central Oregon. It was found that the insect could survive over winter. However, the real threat or impact to native pines was still unknown. Therefore in early 1970, a proposal was made for a larger, "free release," out-planting on an isolated butte in eastern Oregon. Private industry did not want to accept this risk, and therefore the proposal was defeated.

With this background of events, a re-evaluation was again made in early 1971. It was decided at that time that the European pine shoot moth be given a lower priority because of native insects causing known damage. Surveillance surveys of a few communities in eastern Oregon and Washington would be conducted for the next year. Foresters in the Pacific Northwest will have to wait and see if and when the insect is found in native pines, and evaluate the problem at that time. A conventional approach to forest entomology is now being taken.

Complicated Control Decisions: Eslie Lampi

The agencies represented at this workshop session have, as pointed out, individual problems representing various management objectives. It appears that we in the National Park Service, are being "caught" by other agencies in natural, historical, and recreational area management largely because of public pressures that all agencies recognize; i.e. A public interest in land--namely; public recreation, and preservation of unique natural land features.

The National Park Service has been involved in this "new land ethic" (call it that if you will) for a period of years. Many of you have helped us very capably in determining the steps we need to preserving these unique features in our canyon country, our northern and western natural areas, our water recreation areas, historic sites, archeological sites, and our fragile desert environments.

Construction programs, with its related landscaping, during the last few years has placed increased pressure on our forest and tree protection capability. Protection of campground shade trees, shade trees around residental areas, trees planted in a desert environment, adjacent to reservoirs, etc., are not as resistant to damaging insects as for instance desert plants in their suitable habitat.

Under our present pesticide use restrictions by Federal and State Government, which I predict will become more restrictive as time goes on, what will you as professional entomologists recommend as an action program to me as an administrator and a resource manager for control of, as an example, pinyon pine needle scale, tent caterpillar, fall webworm, the species of scolytus responsible for spread of Dutch elm disease, spruce budworm, and the bark beetles?

Many forest insect problems of the past were resolved by a liberal application of DDT, a program that progressed from the old stearman double wing aircraft to faster, heavier aircraft in larger numbers. The eventual public concern for this activity has fairly well cancelled air application of pesticides in the National Park Service--whether we like it or not, we still are within limitations using mist blowers and spray rigs for tree mist control.

I feel that we will remove individual bark beetle infested trees by falling, bucking, and burning techniques as in the past.

Whatever method we use in future insect control work will require more study and review than we have had in the past. If our present control decisions are complicated by past standards. I can only see additional complications in the future. We can only apply control programs you as professionals suggest and that we as administrators and as land managers find possible to apply.

PANEL: HOW SHOULD CONTROL, RESEARCH AND COLLEGE CURRICULA BE REDIRECTED IN LIGHT OF CURRENT CONCERN OVER ECOLOGY AND POLLUTION?

Moderator: Alan Berryman

Panelists: D. Dahlsten, G. C. Trostle, W. M. Hantsbarger, D. C. Schmiege, R. E. Stevens

Redirection of College Curricula in Light of Current Concern Over Ecology and Pollution: D. L. Dahlsten

The recent furor over environmental degradation and over population has had a considerable influence on the educational institutions. Most universities are adding courses in ecology to their curricula as well as various courses in environmental studies. Even within a single university the various colleges are competing for students with environmentally oriented programs. In many cases, the same courses are being taught and only the titles have been changed. There is no question, however, that the students of today are looking for courses with meaning or relevance even though they may end up taking a traditional course with a revamped name.

The approach to understanding and studying environmental problems must be a truly interdisciplinary one. This presents many problems because of the traditional boundaries that have been established along disciplinary lines in the universities. Also, the faculties are really not ready for such a drastic change as witnessed by the development of several competing programs at the same institution.

The problems of teaching environmental studies are numerous. The attempt has been made in many courses to have the experts speak to the students on various pollution or environmental issues. In these cases the course lacks no cohesion as each lecture brings a new face. It is difficult to teach a course with more than two lecturers per quarter much less a whole series of them. There are also budget battles in order for each department to get credit for its participation. Credit or FTE (full-time equivalents) are the bases for departmental budgets.

The type of course to teach presents problems not only with coverage but also with the depth of the material to be given. In some environmental studies courses students from freshmen to graduates and from slavic languages to music and biology are in the same class. The desire on the part of departmental administrators is to have larger and larger classes and therefore greater and greater FTE and then more money for the department. This type of approach is certainly not in the interest of the student. Courses should be designed for each level of student background and these levels should be maintained. Classes might be smaller but the concern should be with quality and not FTE.

There is also a problem of overlap in curricula particularly in the larger institutions. Take, for example, courses in forest, insect, animal, general, and plant ecology. In these courses many of the same principles are taught and again the students come out on the short end as they are faced with considerable repetition if they take more than one of the above courses. In the future there should be some attempt to teach two general ecology courses, one for biology majors and one for liberal arts majors. The same holds true for the environmental studies courses.

The development of a new curricula must be done with the needs of the student in mind at all times. To this end, the committees that formulate the new curricula should have strong representation from the student body. Students today desire more freedom and are looking for solutions to today's environmental problems. They are action oriented in many cases but often find that they are not equipped with many of the basics--physics, chemistry, biology, etc.

Getting closer to home we see that many of these changes are taking place in forestry and entomology. In forestry there has been a tremendous surge of interest but the students seem to be different today. Perhaps their bent is more toward the true concept of multiple use and not just defending multiple use as timber production. Their orientation is much more biological than economical. At some institutions, this attitude on the part of the students is going to increase the incidence of ulcers in the faculty.

In entomology, generally, pest control will no doubt change more to insect population management schemes. The strict chemical orientation of some schools will have to change to meet the needs of the

future. Professional programs will be developed in some cases to produce experts in pest management. These individuals will not be experts in marketing and sales of chemicals but will have a grasp of the principles of integrated control. If the anticipated changes take place in the future there will be many jobs for entomologists in the future. It will take several years to replace all of the salesmen with ecologically oriented advisors. In California, this will be good news to the some 200 prospective Ph.D.'s at Davis, Riverside, and Berkeley campuses. Because of the anti-intellectual atmosphere in the country at this time, university budgets have been cut to the core and jobs are slim. There will, however, always be a need for "pest control artists."

The development of new curricula in the future will need to be innovative, allow the maximum of freedom to student and teacher alike, and must above all be flexible. The success of these new programs will depend upon the breaking down of the traditional barriers within the university so that the programs can be truly interdisciplinary. This approach must transcend from the undergraduate level to the graduate and finally to the research investigator at the unversity. Some generalists will be produced as well as some specialists and there should be jobs for all.

The environmental ills that face man today will only be cured through a broad interdisciplinary approach and as such we as educators hold the key.

G. C. Trostle

We are now able to put considerably better values and inputs into our decision for control than we were 10 years ago. Still, the most important input is the definition of the goal we wish to achieve. We are still unable to agree on that definition of the goal of control.

In the past, we usually thought of "control" as a method to solve any problems involved with large insect populations. The idea was that if we could just suppress the current pest population increases, we could "save the timber" for future generations. There may still be cases where this is just what we want to do--I think we now have a better idea of the possibilities of success.

Some of the ideas, such as the following, held by many forest managers in the past must be updated.

1. That treating of a portion of an infestation is effective.
2. That bark beetles devastate a stand.
3. That the effects of control will last for an extended period.
4. That pests are exterminated by pesticides.

A few of the ideas which should be incorporated into the control discussions are:

1. Suppression of the outbreaks can do no more than reduce population peaks.
2. Outbreaks may develop because of host conditions rather than a release from parasite or predatory pressures.
3. One should capitalize on the trees saved by suppressive action before they are killed by other pests. Trees which die after treatment cannot be counted as "saved" by "control" whether death is one week or 20 years later.
4. There are benefits from prolonging a bark beetle infestation over a period of time through suppression that would not be realized with quicker mortality of the same magnitude without "control."
5. Suppression may be of value in reducing the spread of an infestation.

The decision to suppress an outbreak cannot be made independently. The benefits of control must be weighed against the costs of all the suppression efforts which can be expected during the life of the stand, not just the current threat. As yet, we do not have this information, but the recognition of the need is a large part of the battle.

W. H. Hantsbarger

I am here wearing two hats. One of Extension, our off-campus environmental work in Entomology, and one of a research worker since I am involved in applied research with insecticides. As an Extension Worker, I am interested in all research (chemical, biological, and others) that will furnish information on control of our insect pesticides. The information must be of a practical nature for me to "sell" it to the public.

In spite of all the adverse publicity and considerable attention to non-chemical control, it is my opinion that pesticides are the most important tool to accomplish management of pests. When pest populations reach outbreak proportions or approach economic thresholds, nothing works as quickly as pesticides that affords immediate effects and avoids damage and loss.

Use of agricultural chemicals is expected to increase in the next 10 years at a rate of at least 10 percent annually with the projected population increases and food demands.

Along with the increase of agricultural chemicals, we will see more restrictions on their use. These restrictions will undoubtedly encompass the four following categories:

1. Licensing of chemical applicators.
2. Licensing of salesmen and dealers.
3. Use permits for farmers with certain pesticides.
4. "Hazardous" materials to be applied only by licensed applicators.

Many states now have some or all of the above mentioned restrictions. Colorado has applicator licensing and others are in proposed legislation.

What is needed in research:

1. More information on economic levels or threshold of managing populations.
2. A continous monitoring of levels of pesticide resistance in our major pests.
3. Development of more "selective" insecticides.
4. Alternative methods of control.
   Biological
   Cultural
   Resistant varieties.

One major program in Extension Work is to get people to use the information that is available. In many cases, they use pesticides for convenience where there is reliable information on alternate methods of control. Extension Service has often over simplified the problem by just recommending a chemical control. In the future, we must educate people to a better understanding of the pest and its ecology.

D. C. Schmiege

Nearly everyone has strong opinions and ideas on this subject so I want to be sure at the start that everyone knows that most of what I say is my opinions only. In many cases I have no evidence or data to substantiate what I say.

Environmental quality and ecology are words that are spoken nearly everywhere by many people today. Few of the people talking about these subjects are knowledgeable, but at least interest has been aroused which is needed before any large scale action program can be launched. A few cynics believe this is all a fad and will go the route of the hoola-hoop. Any competent biologist knows that this can't be true. We know that if the human population is not curbed, if non-renewable resources are not managed with less waste, and if we don't prevent the fouling of our life systems, we won't persist as a species indefinitely.

Many of the resource managers both within and outside the Forest Service graduated from colleges about 20 years ago or more. My experience is that many of the forestry schools and biology departments did not discuss the philosophical aspects of man's place in the universe 20 years ago, and were not ecologically oriented as a result. A large percent of the people running things in resource management today do not have a good background in the general field of ecology. If they do, they are largely self taught.

Many universities are now providing courses in resource management that are ecologically oriented. This is fine but we also need to reach more people than college graduates and we need to reach them at an earlier age. This is where we, as professionals in fields associated with resource management, can interact with the public. In recent times, organizations like the U.S. Forest Service have been doing more of this type of interaction where interested people are asked for opinions before resource decisions are made. The public is also receiving more information on what is being done and the reasons for doing it. Despite this hopeful trend, we are still speaking to ourselves for the most part. We need to change this as soon as possible.

A large portion of the people in the world today are saddled with two delusions which stand in the way of looking at our problems realistically. They are:

1. That man has dominion over the universe and that all other living organisms and inanimate objects are here to serve him. This has resulted in a very cavalier and arrogant attitude towards other living animals and plants. We must all learn to recognize that we are simply another animal in the complex and are dependent on other living things for our existence.

2. That technology can solve all of our problems. This is a "fall-out" from our arrogant attitude regarding our place in the whole living scheme. When we realized that technology to date has created more problems than it has solved, we should start to see that it is not the panacea some people have dreamed of.

The general picture of how things are today with overcrowded, filthy cities, polluted air and water and ugly industrial sprawl is the result of a topsy-turvy society. The physical sciences have gone far ahead of the biological and social sciences. In other words, the engineers are running things with a typical bulldozer mentality. The major decisions now made by engineers, lawyers, realtors and politicians nust be at least modified by people with biological understanding and social awareness or man as a species will eventually go the route of the heath hen and the passenger pigeon.

Redirection of Forest Insect Research in the Light of the Current Concern Over Ecology and the Environment: R. E. Stevens

1. Forest insect research will change--is changing--from being heavily economy-oriented to more ecology oriented. That is we are tending more to look at many "problems" from a broader ecological viewpoint.

2. Researchers will have to spend more time in educating and informing. We have many of the technological answers, but these are often unknown to the people who could use them. We have to talk more to laymen, in addition to each other.

3. Research will need to do a better job of looking ahead. We have a tendency to be working on last year's and this year's problems. We need to communicate with forward-thinking land managers, identify potential problem areas before they are upon us, redirect our work, and have answers ready in advance of being inundated.

4. Finally researchers have to develop further the spirit of cooperation. Much of this already exists, but there is need for a lot more. Each of us has to examine his own situation for opportunities to better cooperate with others, and then do it.

WORKSHOP: ECONOMIC AND SOCIAL IMPACT OF INSECT OUTBREAKS ON FORESTS AND FOREST USE

Moderator: D. Ross Macdonald

This workshop was attended by about ten members. Canadian experience with spruce budworm in New Brunswick and balsam woolly aphid in British Comumbia were discussed in some detail. The history of the budworm in N.B. is well documented. The economy and social development of the Province was greatly influenced by the widespread destruction of the forest during the 1912-1920 outbreak. This led to a general collapse of the sawmill industry and governed the development of the pulp industry from about 1928 to the present. It has had a great influence on forestry practice, especially the decision to initiate and continue the series of spraying operations to protect the forests of the Province from the outbreaks that have occurred since the early 1950's.

The economic analysis of the balsam woolly aphid problem in B.C. indicated that dollar losses that could be expected over the next two decades might only amount to approximately two million dollars. The discussion then centered on cost-benefit justifications for research.

It was generally inconclusive and tended to emphasize the difficulties in apportioning values for economic analyses, especially in non-catastrophic outbreaks, and in invasions of introduced pests.

WORKSHOP: TECHNIQUES IN USE TO PREDICT TRENDS OF FOREST INSECTS AND NEEDS FOR CONTROL

Moderator: W. F. McCambridge

Predicting mountain pine beetle trends in ponderosa pine using the sequential method developed by Knight works well, especially during rising epidemics. We are now trying to equate numbers of adults to bark area that will eventually become infested. Considerable variation in broods and stands between infested groups, fly-in and fly-out, and the difficulty of finding adequately isolated infestations frustrate progress.

WORKSHOP: PROBLEMS INHERENT TO EXOTIC INSECT OUTBREAKS

Moderator: Thelma Finlayson

An exotic insect is generally considered to be one accidentally introduced into a new area across a geographic barrier, usually a sea barrier, and usually without its complement of natural enemies. This definition was challenged and it was suggested that an "exotic" species could also be one that for some reason changes its habits or behaviour in its native habitat.

The greatest difference between exotic and native species is that the former have not evolved for countless generations with their environment and therefore usually lack environmental resistance in the form of parasites, predators and microbial pathogens. Outbreaks of exotic species usually have most of the problems associated with the outbreak of a native species plus those are are unique to non-native species.

Workshop discussions were conducted under the following headings:

Identity

The importance of knowing the exact identity of the pest was stressed and several cases were cited where misidentifications resulted in great waste of time, effort and money. The finding of stands of

Japanese larch in the area of larch-casebearer infestations of the Pacific Northwest has raised the question of the origin of the pest. The feeling of the group was that taxonomists should consider all biological data available and publish this with their description of a species.

Status

Discussion of the difficulty in determining whether or not an exotic species is a pest or a potential pest led to the conclusion that information on economic thresholds is too meagre and too subjective.

Life History

A number of cases were reviewed where specific information on the life-histories of exotic species would have spared considerable effort in control attempts. Knowledge of differences in strains of the pest would help in biological control attempts. Cases were cited indicating that life-histories are not static but change over time and in differing places; therefore continuing studies of this nature are required.

Controls

The word "control" can have either economic or ecological meaning but the group confined its discussion to the former. Time limited discussion to a consideration of only biological control. Relative merits of introduction of a single efficient biotic organism versus multiple introductions were reviewed. It was felt that the difficulty of selecting a "perfect" biotic agent would be an insurmountable barrier to single introductions because it is rarely possible to predict what will happen in the field.

There was a strong feeling that problems of exotic insect outbreaks would not arise if there were tighter quarantines on the flow of living materials from place to place.

MINUTES OF THE FINAL BUSINESS MEETING
March 4, 1971

The meeting was opened by Chairman Dave Wood at 2:55 p.m. in the Colorado Room, Hotel Colorado, Glenwood Springs, Colorado

The nominating committee nominated Boyd Wickman to serve as councilor for the period 1972 through 1974. There were no further nominations. Boyd Wickman was unanimously elected.

The meeting place for 1973 was discussed. Paul Buffam strongly recommended Tucson as having good meeting facilities, a good winter climate, and a good location relative to Nogales. Bill McCambridge recommended Santa Fe as an interesting town where we had not met previously. Others pointed out Sante Fe is likely to have bad weather in early March and has less to offer than Tucson.

It was moved by Jack Schenk and seconded by Roy Shepherd that the 1973 meeting be held in Tucson. Passed by majority vote.

Treasurer Tom Koerber reported paid registration at the meeting was 122, and a profit was made to make up most of the loss at last year's meeting.

Balance received from Les McMullen		$296.14
Interest received on bank account		1.33
Balance on hand prior to meeting		297.47
Receipts from 22nd annual meeting		816.75
	Total	1,114.22
Expenses of meeting		585.15
Balance on hand at end of meeting		529.07

Chairman Dave Wood asked for constructive criticism of the meeting. Alan Berryman commented there was not enough choice of topics and the discussion groups were too big. Roy Shepherd commented that people ought to make more suggestions for topics on the program. Ron Stark and Don Dahlsten said that ski meet before the meeting was an excellent innovation. Walt Cole said a recreation break at the meeting was OK, but a day off in the middle of the week was hard to justify administratively.

Bill McCambridge pointed out that a series of meetings on the International Biological Program, which were not open to the general Work Conference membership, had been held concurrently with the workshops. People who would have participated in the Work Conference instead attended the IBP meetings and were not available to contribute to the Work Conference proceedings. It is a bad idea to hold other meetings concurrently with the workshops. Ron Stark explained why the IBP meetings were being held and agreed they had a bad effect on the Work Conference.

Walt Cole reported for the ethical practices committee. For his outstanding performance as a belly dancer at the Denver Hotel bar, the chairmanship of the ethical practices committee was awarded to Dan Jennings.

The meeting adjourned at 3:21 p.m.

Thomas W. Koerber, Secretary

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OF THE TWENTY-THIRD ANNUAL

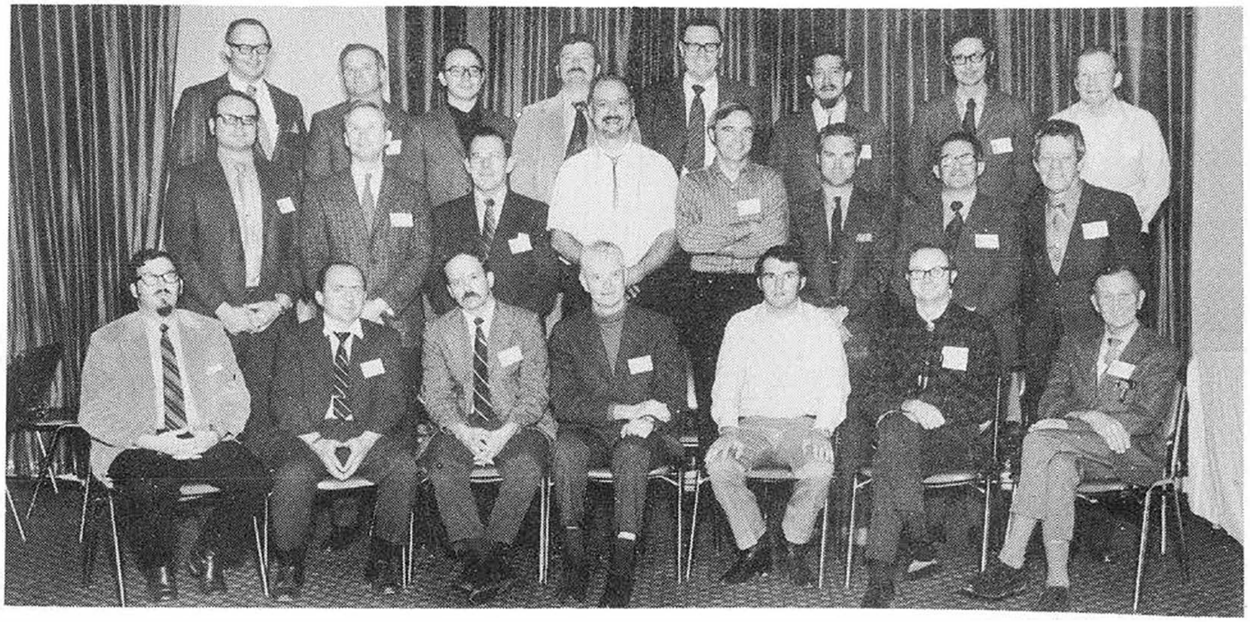
WESTERN FOREST INSECT WORK CONFERENCE

Edmonton, Alberta

March 6-9, 1972

Not for Publication

(For information of Conference Members only)



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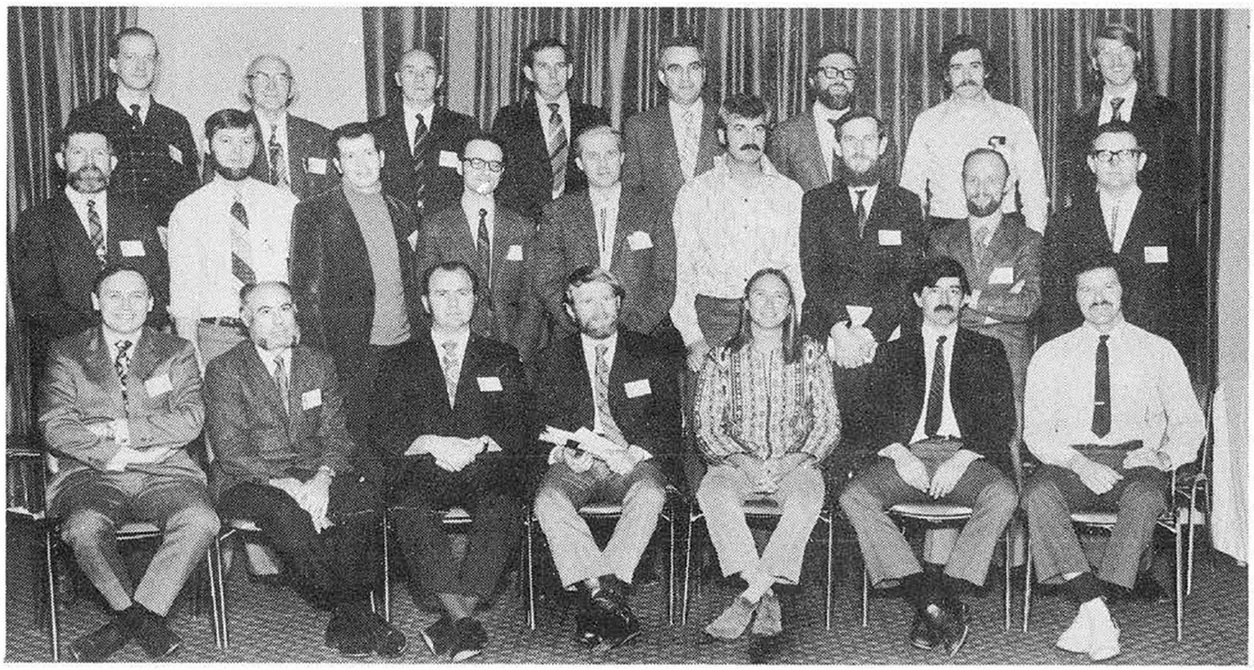

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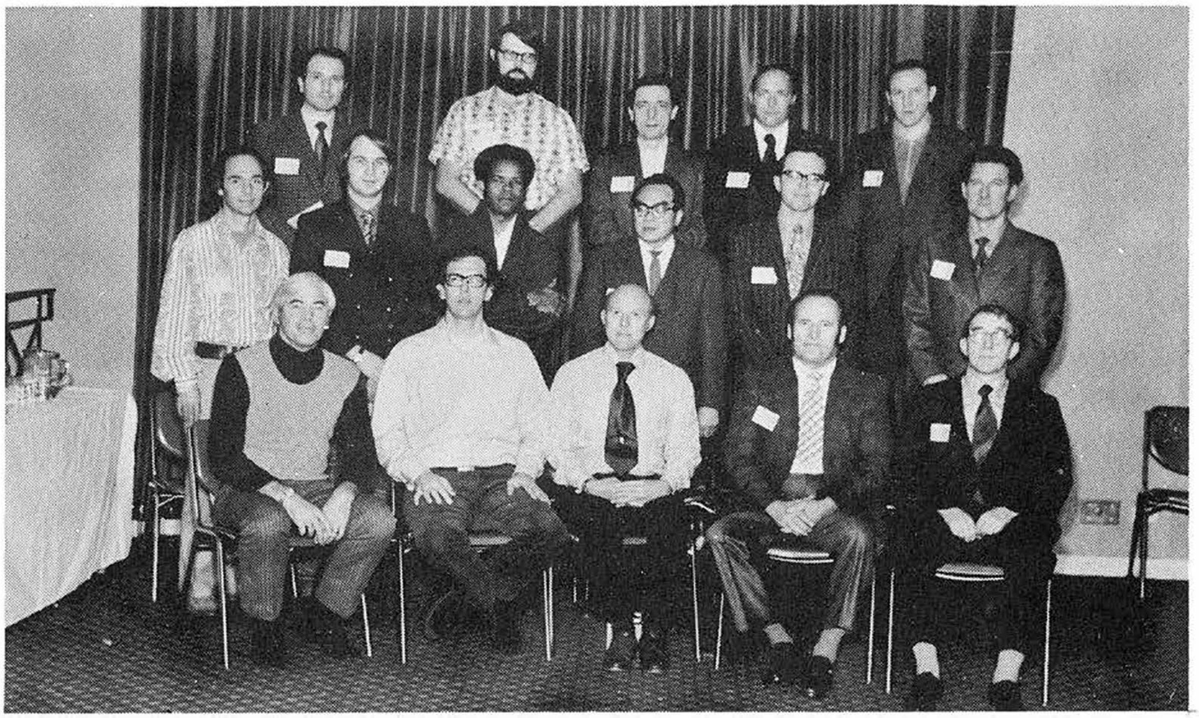

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PROGRAM

TWENTY-THIRD ANNUAL WESTERN FOREST INSECT WORK CONFERENCE
HOTEL MACDONALD, EDMONTON, ALBERTA
March 6-9, 1972

Sunday, March 5

8:00 p.m. - 10:00 p.m.	Resistration
8:00 p.m. - 10:00 p.m.	Executive Committee meeting

Monday, March 6

8:30 a.m. - 5:00 p.m.	Registration
9:00 a.m. - 10:00 a.m. Rupert's Land Suite	Initial business meeting
10:00 a.m. - 10:30 a.m.	Coffee
10:30 a.m. - 11:30 a.m.	The Program of the Department of the Environment of the Government of Alberta as it Affects Resource Development.--E. E. Ballantyne, Department of the Environment, Government of Alberta (Substituting for W. J. Yurko, Minister, same Department).
11:30 a.m. - 1:00 p.m.	Lunch
1:00 p.m. - 3:00 p.m. Rupert's Land Suite	Panel: Environmental Protection Needs in Boreal Resource Development. Moderator: E. B. Peterson, Northern Pipeline Study, Environment Canada, Edmonton, Alberta How an Environmental Impact Statement is Prepared.--John M. Heckard, Dames and Moore Consulting Engineers, Earth Sciences Laboratory, Cincinnati, Ohio

	Developments and Environmental Protection.--J. P. Parkinson, Ecological Protection Branch, Environment Canada, Ottawa, Ontario
	Some Legal Viewpoints on the Problems of Environmental Impact Assessment.--J. L. Dewar, Faculty of Law, University of Alberta, Edmonton, Alberta
3:00 p.m. - 3:15 p.m.	Coffee
3:15 p.m. - 5:00 p.m. Edmonton Room	Concurrent Workshops: Sampling Bark Beetle Populations and Prediction of Population Trend. Moderator: C. J. DeMars, Pacific Southwest For. and Range Exp. Stn., Berkeley, Calif.
Churchill Room	The Role of Microorganisms in the Epidemiology of Bark Beetles. Moderator: H. S. Whitney, Canadian Forestry Service, Edmonton, Alberta
Rupert's Land Suite	Insecticide Appraisals for Effects on Non-target Organisms in the Forest Environment. Moderator: R. E. Pillmore, U.S. Fish and Wildlife Service, Denver, Colo.

Tuesday, March 7

8:30 a.m. - 10:15 a.m. Maligne Room	Concurrent Workshops: Working Toward an Ideal Relationship Between Ecologists and Taxonomists. Moderator: H. R. Wong, Canadian Forestry Service, Edmonton, Alberta
Rupert's Land Suite	Bark Beetle Attractant Tests in 1971. Moderator: L. N. Kline, Oregon State Forestry Department, Salem, Oreg.
Edmonton Room	Climatic Effects on Insects in the Boreal Forest. Moderator: J. S. Hard, Pacific Northwest For. & Range Exp. Stn., Juneau, Alaska

Churchill Room	Aerial Photography in Forest Pest Surveys. Moderator: W. M. Ciesla, U.S. Forest Service, Missoula, Mont.
10:15 a.m. - 10:30 a.m.	Coffee
10:30 a.m. - 12 noon Rupert's Land Suite	<u>Panel:</u> The Epicenter Concept in Forest Insect Control. Moderator: D. R. Macdonald, Canadian Forestry Service, Victoria, B.C. D. O. Greenbank, Canadian Forestry Service, Fredericton, N.B. R. F. Shepherd, Canadian Forestry Service, Victoria, B.C. W. G. H. Ives, Canadian Forestry Service, Edmonton, Alberta
12:00 noon - 1:00 p.m.	Lunch
1:30 p.m. - 2:30 p.m.	Tour of the Northern Forest Research Centre. Welcoming address by M. H. Drinkwater, Northern Forest Research Centre, Edmonton, Alberta
3:00 p.m. - 5:00 p.m.	Curling

<u>Wednesday, March 8</u>

8:30 a.m. - 10:15 a.m. Rupert's Land Suite	<u>Panel:</u> Stress-Physiology of Conifers With Emphasis on Insect Attack and Moisture. Moderator: R. W. Reid, Canadian Forestry Service, Edmonton, Alberta D. M. Shrimpton, Canadian Forestry Service, Edmonton, Alberta H. M. Etter, Canadian Forestry Service, Edmonton, Alberta B. Mullick, University of British Columbia, Vancouver, B.C. G. S. Puritsch, Canadian Forestry Service, Victoria, B.C.
10:15 a.m. - 10:35 a.m.	Coffee

10:35 a.m. - 12:00 noon	Discussions of the Future of our Work Conference in Three Groups With the Following Moderators:
Edmonton Room	E. D. A. Dyer, Canadian Forestry Service, Victoria, B.C.
Maligne Room	R. W. Stark, University of Idaho, Moscow, Idaho
Churchill Room	R. I. Washburn, Intermt. For. and Range Exp. Stn., Moscow, Idaho
12:00 noon - 1:00 p.m.	Lunch
1:00 p.m. - 3:00 p.m. Rupert's Land Suite	Concurrent Workshops: Insect Photography Moderator: M. M. Furniss, Intermt. For. and Range Exp. Stn., Moscow, Idaho
Edmonton Room	Biotic Control Factors. Moderator: J. A. Muldrew, Canadian Forestry Service, Edmonton, Alberta
Churchill Room	Root and Tip Weevils. Moderator: L. H. McMullen, Canadian Forestry Service, Edmonton, Alberta
Maligne Room	Cone and Seed Insects. Moderator: T. W. Koerber, Pacific Southwest For. and Range Exp. Stn., Berkeley, Calif.
3:00 p.m. - 3:20 p.m.	Coffee
3:20 p.m. - 5:00 p.m. Edmonton Room	Concurrent Workshops: Degree-Days in Relation to Insect Development and Abundance. Moderator: W. G. H. Ives, Canadian Forestry Service, Edmonton, Alberta
Rupert's Land Suite	Insect Photography (continued).
Maligne Room	Primary Attraction and Host Selection by Forest Insects. Moderator: K. Graham, University of British Columbia, Vancouver, B.C.
Churchill Room	Evaluating Growth Impact. Moderator: C. Sartwell, Pacific Northwest For. and Range Expt. Stn., Corvallis, Oreg.

8:00 p.m. Eldorado Room	Banquet and Entertainment
Thursday, March 9 8:30 a.m. - 10:00 a.m. Rupert's Land Suite	Panel: Cost-Benefit Analysis of Research. Moderator: J. Smyth, Canadian Forestry Service, Edmonton, Alberta J. E. Marshall, Forest Economics Research Institute, Ottawa, Ontario T. Tucker, Canadian Forestry Service, Sault Ste. Marie, Ontario R. B. Forster, Forest Economics Research Institute, Ottawa, Ontario
10:00 a.m. - 10:20 a.m.	Coffee
10:20 a.m. - 12:00 noon Rupert's Land Suite	Final Business Meeting

MINUTES OF THE INITIAL BUSINESS MEETING
March 6, 1972

The meeting was opened at 9:10 a.m. by Chairman David Wood. The minutes of the previous meeting were read and approved.

Treasurer Tom Koerber reported that last year's Work Conference made a profit of $259.93. In the course of the year, we collected $60.50 in dues and $23.15 from interest, giving us a balance of $612.72 on hand. At this point we have made up for the loss on the 1970 meeting and since the present meeting has been budgeted to make a little money. The Work Conference is again in sound financial condition.

In answer to an inquiry on the status of the proceedings of the last meeting, Secretary Tom Koerber reported that workshop chairmen were late in submitting their reports and some had still not come in. He is preparing to issue the proceedings without them.

Chairman David Wood appointed a Nominating Committee under the Chairmanship of C. J. DeMars. Nominations for chairman, secretary-treasurer and councilor are in order.

Program Chairman Les Safranyik announced that Deputy Minister of Environment for Alberta, E. Ballantyne, would give the keynote address. He also mentioned that the Executive Committee had tentatively approved the expenditure of $50.00 to pay the expenses of Evan Gushul, who will conduct the workshop on insect photography. The Executive Committee does not intend this to be a precedent, but only a way to deal with the unforeseen circumstance that Mr. Gushul would not be attending the meeting at Government expense. It was moved by C. J. DeMars that the Executive Committee be given a vote of confidence on the matter--passed unanimously.

Paul Buffam presented propaganda including a slide show to encourage attendance at next year's meeting which will be held from March 5 to 8, 1973, at Tucson, Arizona. Tucson, tacos and tequila were said to be a very pleasant combination. Bob Frye will serve as program chairman.

Walt Cole rose to speak in favor of the Salt Lake City area as a site for the 1974 meeting.

Stu Whitney proposed a joint meeting of the Western Forest Insect Work Conference and the Western International Forest Disease Work Conference.

Fields Cobb supported the proposal with the suggestion that the Lake Tahoe area of California would be a good place to hold the joint meeting.

Pete Orr suggested that the Corvallis-Portland, Oregon area be considered as a meeting site for the 1974 meeting.

Roy Shepherd announced that Bob Furniss is nearing completion of the revision of Insect Enemies of Western Forests. He has assembled an extensive list of references on forest insects. It was suggested that the references, which are on computer tape, would be useful to forest entomologists. Chairman David Wood appointed Roy Shepherd, a committee of one, to look into the possibility of making the references available in advance of publication of the book.

The meeting adjourned at 10:03 a.m.

THE PROGRAM OF THE DEPARTMENT OF THE ENVIRONMENT OF THE GOVERNMENT OF ALBERTA AS IT AFFECTS RESOURCE DEVELOPMENT

E. E. Ballantyne, Department of the Environment, Government of Alberta

On behalf of the Minister of the Environment, the Honourable W. J. Yurko, and the staff of the Department, I wish to extend a welcome to you. As I understand it, we are honoured to have representatives of your Association all the way from Texas and Arizona right through to Alaska, with the majority of your members from the Plains area of Canada and the United States.

You will find Alberta quite a Province. It is the energy Province of Canada, with pipelines from here to Toronto and Montreal, to New York State, to Chicago and California. Also, another large part of the environment is in the agricultural industry and this Province produces 30% of the red meat in Canada, it is first in barley production in Canada, second in wheat, first in beef, first in sheep, horses and grass seed, and we also have close to one million acres of irrigation.

The beauty here is terrific and a lot of it is due to the green trees which are of interest to you. I should mention, too, that Alberta being situated as it is at the headwaters of important river units where the water goes to the Arctic Ocean, to Hudson Bay and even to the Gulf of Mexico means that there is a great responsibility on those involved in the forest industry to preserve this environment and protect these watersheds.

In addition to the above reference to protecting the watershed, I wish to add that forestry has an important role in the production of oxygen and the use of carbon dioxide. I do not have the CO_2 figures for forest production, but I am sure that a well managed forest will be something like the following in agriculture. With a 100 bushel crop of corn, enough oxygen is produced for eight people for a year; if this is increased to a 200 bushel crop, enough oxygen is then produced for 16 people for a year. Conversely, of course, there is use of carbon dioxide in about the same ratio. Also, forests run one of the biggest recycling enterprises conducted by nature. All of these items indicate the importance of forestry which, along with agriculture, has a key environmental impact for the future, not only of Canada and the United States, but also for the world.

In speaking today on the Department of the Environment, I wish to outline some of the philosophies that are basic to the way the Department is organized so that you will have a better understanding of it and of our objectives.

Objectives

First, I would like to submit the definition for "environment," which is as follows:

> "... the following are matters pertaining to the environment: (a) the conservation, management and utilization of natural resources; (b) the prevention and control of pollution of natural resources; (c) the prevention of noise and the control of noise levels resulting from commercial or industrial operations in so far as they affect the environment in the vicinity of those operations; (d) economic factors that directly or indirectly affect the ability of persons to carry out measures that relate to the matters referred to in clauses (a), (b) and (c); (e) any operations or activities
>
> (i) that adversely affect or are likely to adversely affect the quality or quantity of any natural resource, or
>
> (ii) that destroy, disturb, pollute or alter or make use of a natural resource or are likely to do so;
>
> (f) the preservation of natural resources for their aesthetic value; (g) laws in force in Alberta that relate to or directly or indirectly affect the ecology of the environment or natural resources." (Ref. Clause 2, The Department of the Environment Act).

The objective of the Department--or, more correctly, the objective of the Government of Alberta--is to conserve and improve the environment so that people living here five years, 50 years or 500 years from now can enjoy Alberta, as well as those living here at the present time.

The Department is not doing everything itself, but is responsible for coordination of the policies, programs and services to the administrative procedures or departments of the government and of government agencies in matters pertaining to the environment. (Ref. Clause 8. (a), The Department of the Environment Act)

Organization

Attached are three charts: #1--total organization of the Department, #2--organization of the Standards and Approvals Division, #3--organization of the Pollution Control Division.

Brief specific remarks on several parts of the organization are as follows. (a) You will note that the Environment Conservation Authority reports directly to the Minister. It is charted on the side to show that it is essentially not part of the Department, but reports only to the Minister. It is Ombudsman-like in principle and is used as a public forum to get reactions direct from the public. As you

THE DEPARTMENT
OF THE
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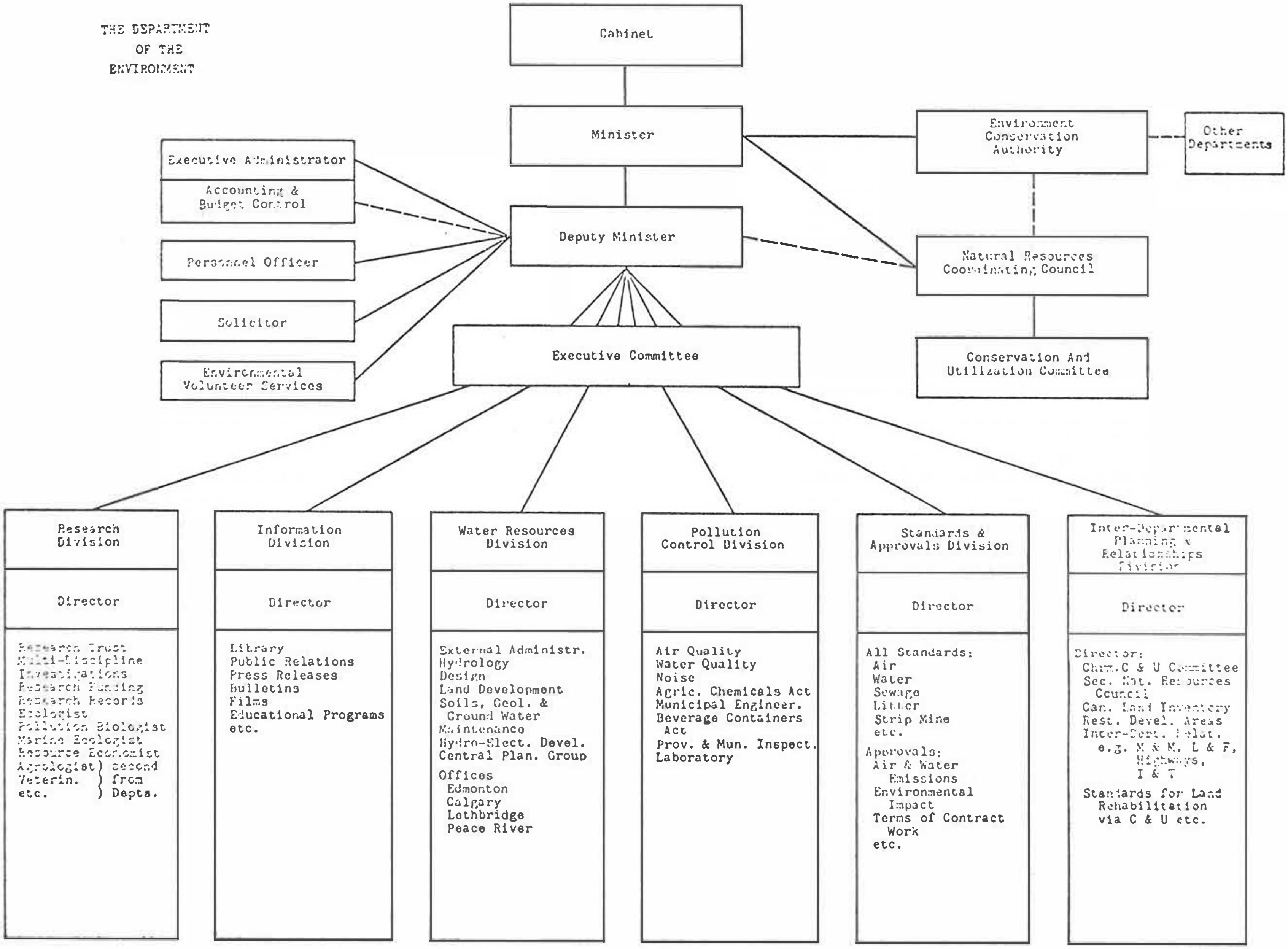
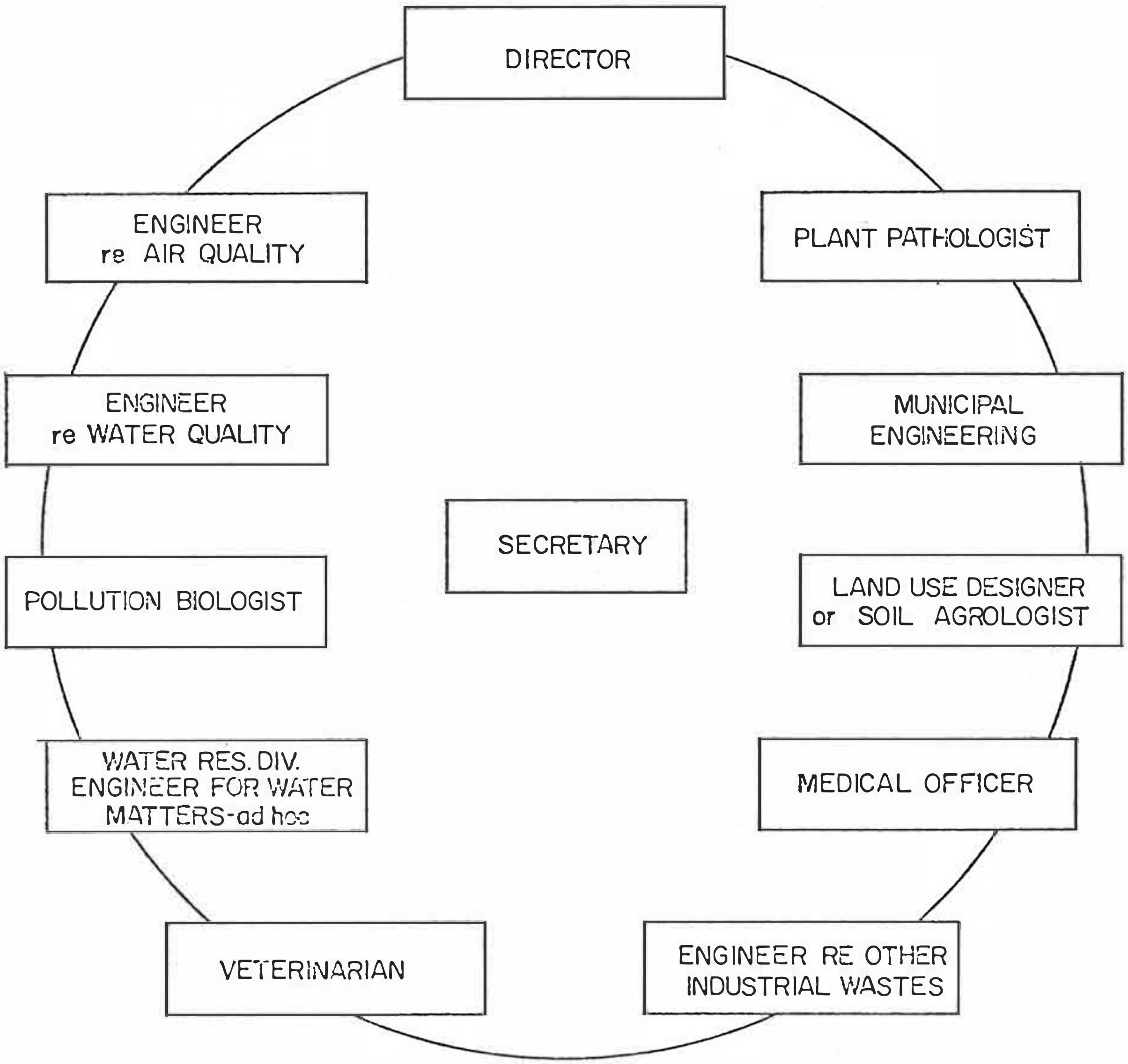
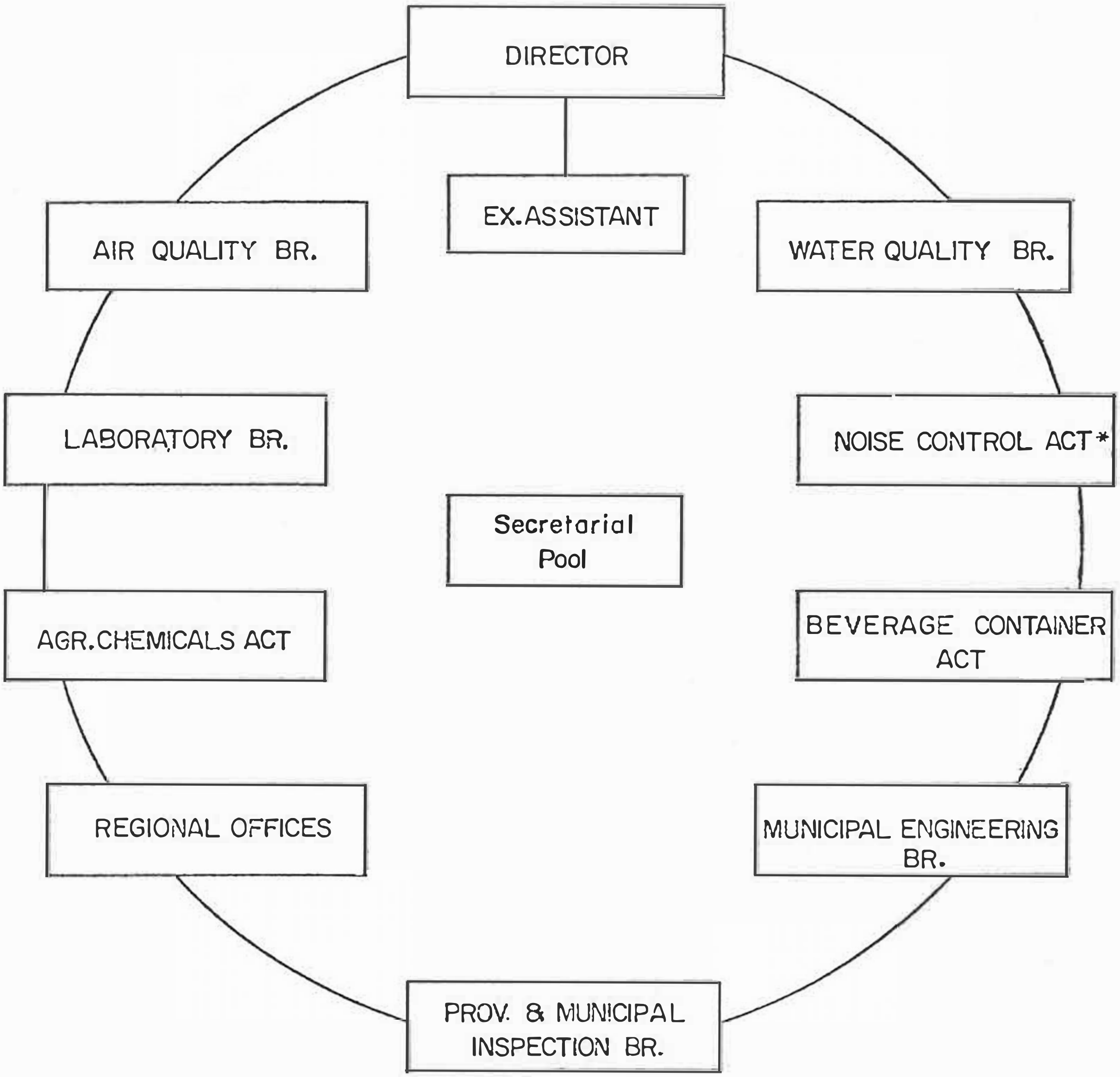


December 1, 1971.

STANDARDS AND APPROVAL DIVISION



POLLUTION CONTROL DIVISION



* when and if legislation enacted

are aware, the Authority has held several hearings such as that on strip mining, etc. where the public inputs are then compiled and reported to the government. This information will be of real value to the Minister in presenting a bill on surface land conservation to the Legislature at a later date. (b) The Natural Resources Co-ordinating Council and the Conservation and Utilization Committee are off on the right-hand side of the chart. They are put in this position to show that they are interdepartmental. The Co-ordinating Council is made up of the Deputy Ministers of the resource departments, and the Conservation and Utilization Committee is made up of technical people from the various Departments. The Co-ordinating Council and the Conservation and Utilization Committee are two of the most important units for departmental co-ordinating and development of recommendations that you could find anywhere in the government. (c) The Research Division will be mainly a funding division and will not have a research staff of its own except a few for investigational purposes such as a biologist, resource economist, ecologist, etc. Other disciplines as required will be seconded from other departments. There is an Environmental Research Trust which has money and which will solicit additional funds from outside sources. The Board of Trustees has just been set up and the Trust should be fully operational very shortly. (d) The Information Division will put an emphasis on the educational aspects through preparation of bulletins, films, news releases, etc. which will be provided to schools and to the general public. In addition, they are building up a library on environmental matters for the use of the Department and for anyone else in the Government who is interested in this subject. (e) The Water Resources Division was one of the core divisions in setting up the Department and was transferred from the Alberta Department of Agriculture. All water development and conservation in the province is handled by this Division. (f) The Pollution Control Division -- first, I should say that the original Pollution Control Division (which had previously been Environmental Health Services in the Department of Health) was transferred to this Department and has subsequently been reorganized into the Pollution Control Division and the Standards and Approval Division. Organization charts are attached. By the reorganization we have separated the judiciary from the police force, in principle, and have provided for an expansion of inspection services as well as a more comprehensive approach to the granting of approvals on pulp mills, oil refineries, etc., etc. Specifically, under the Pollution Control Division you will note that the Agricultural Chemicals Act is there for administration. This was transferred from the Department of Agriculture. Also, there is inspection for water works, sewage plants, air pollution, water pollution, The Beverage Container Act administration, etc. A considerable amount of enforcement duties will be assigned to other Departments or agencies who have well trained staffs in certain fields. (g) The Standards and Approvals Division--this is a new Division, as mentioned above, and gives a multi-discipline and inter-discipline assessment of approvals and also multi-discipline and inter-discipline input in establishing standards. You will note that the end point effects of pollution will be covered by people trained in specific fields such as a

plant pathologist, biologist, veterinarian, medical officer and a soils expert, in addition to the chemical engineers on air quality, water quality, municipal engineering and industrial wastes. The engineer on industrial wastes is also a new one because there are many things that can be quite toxic in industrial units that have to be considered. This approach is a first in Canada and the comments from outside sources to date have been very favorable on Alberta setting up a mechanism for a comprehensive attack on pollution. (h) The Interdepartmental Planning and Relationships Division will be working out specific roles of the Department of the Environment and of other departments, because our Department is not going to be doing all the work. For example, some of the enforcement will be done by the Energy Resources Conservation Board, the Department of Lands and Forests, counties, cities, etc. Therefore, what each one is responsible for has to be outlined. For continuity purposes, the Director of this Division is the Chairman of the Conservation and Utilization Committee and the Secretary of the Co-ordinating Council.

In this Division, too, you will find "R.D.A.s", which means Restricted Development Areas. The concept is that there is a place for conservation of the environment co-existent with the development of natural resources. There could be several categories of R.D.A.s, ranging all the way from no development right through to probably four or five different types. Each one would know before they started what the rules of the game were so that the environment wouldn't be destroyed. In other words, the government role is to emphasize prevention. Activities that could co-exist would be transportation, lumbering, recreation, strip mining, gas and oil wells, etc.

Also, just last week the Surface Reclamation Board was transferred to the Department of the Environment and has been assigned to this Division. (i) Legislature--The Department will be responsible for the following Acts:

The Department of the Environment Act
The Clean Air Act
The Clean Water Act
The Alberta Environmental Research Trust Act
The Beverage Container Act
The Agricultural Chemicals Act
The Water Resources Act
The Ground Water Control Act
The Litter Act
The Surface Land Conservation Act

These Acts can be tough, as "Stop Orders" can be issued to even close a polluter down but there is a right of appeal to the Minister, who may request the Environment Conservation Authority to conduct an inquiry. For littering, there will be "Clean Up Orders" so the litterer has the option of cleaning up his mess--or go to court.

Studies

The Department has several studies being done by consultants to establish the facts before legislative action (if necessary) is taken. They are studies on:

1. Odor - Edmonton and Calgary
2. Noise - Edmonton and Calgary
3. Deep well disposal of toxic substances
4. Environmental aspects of the tar sands development
5. Lake Wabamun - industrial, municipal, agricultural effects
6. Emission and source inventory

There are also several internal or interdepartmental studies, such as on feedlots and animal wastes, gas extraction plants, the irrigation use of sewage effluent, etc.

The Department has participated in the use of sensors; is active in the oil spill control program; etc., etc.

Finally, it will suffice to say that the Department is action oriented and the Government, under The Department of the Environment Act, can have Government action co-ordinated in a very definite and positive way.

Plants and Man

I wish to quote an item that summarizes some of the key roles of your industry and related aspects.

"Plants Benefit Man[1]

"Dr. John Carew, horticulturist at Michigan State University, lists the following benefits of plants to man:

(1) Noise protection. Plants act like acoustical tile and absorb sound. This makes them useful along highways.

(2) Dust filters. Plants filter dust and pollution particles from air. A tree's leaf surface may be 10 times greater than the area it shades.

(3) Protection from sun.

(4) Protection from winds. Tree plantings reduce the effect of wind and help reduce wind erosion.

(5) Privacy. Some plants make attractive backyard fences or can be used to hide undesirable sights such as junkyards, dumps, or used car lots.

(6) Air conditioning. The water that evaporates from plant leaves can cool air as much as 15 to 20 degrees. In a recent test, air temperature above synthetic turf at Michigan State University's Spartan Stadium was 93 degrees but was only 85 degrees above nearby natural grass areas. Home owners have found that green concrete or plastic lawns are too hot to enjoy.

(7) Better soil. Plants help keep soil porous and absorbent so that it soaks up rain. A 1-inch rainfall on a 30-acre paved parking lot produces over 600,000 gallons of runoff water. Areas of ornamental plants in these parking lots would help to absorb this water and avoid excessive runoff.

(8) Therapeutic agents. Living plants provide an effective therapeutic atmosphere for the physically and mentally regarded, for prison inmates, and for patients in hospitals.

(9) Wildlife habitat. Plants provide both needed cover and food for birds and animals.

(10) Food and fiber for man.

(11) Attitude changer. 'In one Michigan city, an industrial plant with no landscaping and unattractive grounds had an unmanageable litter problem while employees of a beautifully landscaped plant were careful not to litter the grounds.'"

[1] Arborists News, International Shade Tree Conference Inc., Vol. 36, No. 9, September 1971

Conclusion

In concluding this address, I would emphasize that we are firm believers that policy should be based on the best known scientific facts available and as scientists you have a real obligation in this regard. Also, you have a role to play in the evaluation of policies and programs because again, it can only be done by a critical analysis of what has been achieved in the scientific sense.

I note that your conference is of a workshop type. I commend you for this because the more scientists sit down with administrators and discuss matters from the viewpoint of both, the better each will become.

We trust that we have given you a few ideas and insights into our mode of operation in Alberta which may be of some interest to you.

PANEL: ENVIRONMENTAL PROTECTION NEEDS IN BOREAL RESOURCE DEVELOPMENT

Moderator: Everett B. Peterson

Panelists: J. M. Heckard, J. P. Parkinson, J. L. Dewar

Introductory Remarks by Panel Moderator: Everett B. Peterson

This conference brings us together at the southern edge of the earth's most widespread vegetation zone--the great circumpolar boreal forest that is shared between the U.S.S.R., Canada, Alaska, and the Scandinavian countries. Some of the specific questions being discussed in your workshops of the next few days are a reflection of important biological features of this vast vegetation zone. Similarly, as the title of this panel indicates, our opening discussion here will focus, where appropriate, upon those aspects of environmental protection that would be most influenced by the special features of the boreal forest. This task of specifically relating environmental protection needs to features of the boreal forest I have assigned to myself; the other three panelists will concern themselves less with boreal resource development and more with their own concepts and vantage points of environmental protection.

The intent in assembling this panel was to choose a topic of general scientific and administrative interest and the three panelists were selected on that basis. It is an international panel to match the audience that is here. The panel, when considered together with the presentation by a provincial representative in this morning's keynote address, was also meant to provide a good sampling of diverse institutional backgrounds with Mr. Heckard speaking both as an independent environmental consultant and as a person with United States experience in these matters, Mr. Parkinson speaking from his vantage point in the federal government of Canada, and Mr. Dewar speaking from the viewpoint of the academic legal community.

Let me interject that in arranging this panel I have provided little guidance to the panelists, except to pre-circulate a set of questions to each of them. Whether or not the panelists address these questions has been left entirely up to them. I believe that copies of these questions were distributed to the audience this morning and I hope that some of them are sufficiently provocative to ensure that we have a lively discussion for the full two hours.

Before I introduce the panelists for their opening remarks, let me focus for a few minutes upon several important ecological features of the boreal forest zone. In doing this I will attempt to indicate how these features might have a bearing on the aspects of environmental protection and impact assessment that the panelists are going to discuss.

The boreal forest, being Canada's and Alaska's most widespread and typical landscape, gives the impression of great similarity over a broad geographic area with the result that boreal resource developers may possess an unjustified sense of security in broad geographic extrapolation of test results. There is a logical tendency to think that there is no difference between the spruce-larch stands that are influenced by Labrador's Churchill Falls power dam, by Quebec's proposed James Bay water diversions, or by western subarctic hydrocarbon extraction projects, simply because the dominant tree species in each of these three examples are the same. Biologists know the weaknesses of such over-simplified and widespread extrapolation; they know that assemblages of species depend very much upon local and small-scale variations in landform, disturbances, history of lightning fires, subsurface water or ice distribution, or availability of seed sources. It is these small-scale variations that give a complex mosaic pattern to what is otherwise a broad, monotonous vegetation zone. It is also these same small-scale variations that make isolines on a map and regional averages (such as average peat thickness or average depth of active layer) quite meaningless. The authors of environmental impact statements might bear these features in mind.

In this same context it can also be argued that even though there is widespread occurrence of boreal species, these species are actually composed of a great number of ecotypes each of which is a local population adapted to its area of occurrence. Recognizing this as an added deterrent to the extrapolation of impact study results, there appears to be a need for environmental impact assessment for each major resource development project even if the project is involved with terrain, vegetation types and species that appear to be the same as have been studied elsewhere.

Another significant ecological phenomenon can be observed at the northern and southern limits of the boreal forest. This zone has fingers that extend, in favored habitats, into the treeless tundra in the north and into the treeless prairie in the south. In both cases, these fingers of favored habitat for boreal species are topographic low points. River valleys support boreal forest species well into the tundra (as along the Mackenzie River or the Firth River in the Territories and the Yukon). So, too, do river valleys allow penetration of these same boreal forest species into the grasslands (as along the Red Deer River in Alberta). These phenomena again point to the dangers of relying upon isolines drawn in broad sweeps from northwest to southeast across boreal North America. The decision-maker involved with a resource-development project in a valley may be dealing with one of these "fingers" of outlying preferred habitat for boreal species and he may need to design his project for boreal conditions even though the latitude or the isolines on his map may tell him he is north of the boreal zone.

The boreal forest occurs on a young landscape that, in an ecological time frame, is in the early phases of recovery from continental glaciation. This young glaciated surface is dominated by boreal tree species (the spruces, larch, birch, poplars and willows) that have light-weight wind-borne or water-borne seeds. This gives these species considerable capability for inhabiting newly exposed surfaces such as moraines, sand-bars, land-slip surfaces or man-made engineering works. These are obviously important practical applications of these natural adaptations for one whose task it is to design the revegetation or stabilization phases of man-made surface disturbances.

The relative youth of the boreal forest expresses itself in another important way. Forest stands have a small number of dominant species with the result that these relatively simple stands are subject to insect or pathogen outbreaks of epidemic proportions. A knowledge of this phenomenon is important to those attempting to assess environmental impact of resource development projects because it is necessary always to be able to differentiate between symptoms attributable to the resource development project and symptoms attributable to natural disruptive forces such as insect outbreaks. The fact that populations of consumer organisms do tend to oscillate widely in the boreal forest and the fact that outbreaks are part of the cycle of development to which boreal forest ecosystems are adapted are themselves clues that the boreal forest possesses strong inherent capabilities to recover from disturbances that are within its range of evolutionary experience.

Rowe has described the boreal forest as the "fire forest" par excellence. In it there has been selection for species that can sprout or spread seed widely after burning. Aside from the role of fire in creating and maintaining the small-scale pattern of variation, referred to earlier, acceptance of the important role of fire has implications for the concept of "stability" in the boreal forest. The stable parts of the boreal forest will be the topographically fire-proof locations such as open sand hills, rock ridges or wetlands. Environmental impact assessment will be incomplete, in my opinion, if it is not cast in terms of the resource development project's potential effect upon both the "stable" and the "less stable" segments of the boreal landscape.

Another important feature of the boreal forest zone is the pronounced seasonal periodicity. For environmental impact studies this means that we must always ask not only on what segments of the boreal landscape are these results applicable but also at what times of year are the results applicable. I am sure that Mr. Heckard's experience with preparation of environmental impact statements could provide us with several good examples that would demonstrate the importance of seasonal periodicity.

Vast areas of the boreal forest in Canada remain sparsely populated. Therefore, this zone will receive impact not from thousands of individual land use operations as was the case when the grasslands were "developed." Instead, boreal resource developments, for economic reasons alone, will be large and will be few. This increases the chances of the overall environmental impact to be assessed--an assesment that would be impossible if there were hundreds of thousands of "developers" as there is in an agricultural settlement era. Let us then turn to hear the ideas of our panelists on alternative approaches to environmental protection for an area such as the boreal forest.

How an Environmental Impact Statement is Prepared: J. M. Heckard

Abstract: The National Environmental Policy Act of 1969 stipulates that Environmental Impact Statements (EIS) must be prepared for all major federal actions which significantly affect man's environment. Section 102 (C) (2) of that Act specifies that the following five items be addressed in the EIS:

a. The environmental impact of the proposed action,
b. Any adverse environmental effects which cannot be avoided should the proposal be implemented,
c. Alternatives to the proposed action,
d. The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
e. Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

In some cases, private industry is required to prepare a draft for EIS and submit that to the federal agency. The federal agency reviews that draft with the industrial company, and after some revision, circulates it to other agencies and the public for review. Comments from these agencies are incorporated (if appropriate) in the EIS, which is submitted to the Council on Environmental Quality. As a result of these analyses, several projects have been stopped because the environmental cost was deemed to be too great. Hundreds of other projects have been redesigned to minimize or alleviate environmental impact.

There are five basic steps in the preparation of an EIS. Step one is called "Preliminary Assessment" and it entails the mobilization and briefing of the project team leaders, inspection of the site and the preparation of a project plan, which identifies specific tasks, responsibilities and schedules for the individual investigators.

Step two consists of data collection (from all possible sources) and the evaluation of the data to determine its adequacy.

Step three, Data Analysis, includes a complete description of the baseline conditions and the proposed action. The impact of that action on the baseline conditions is then described in terms of the five points in NEPA.

Step four, Report Finalization, consists of a final drafting with all appropriate company officials and legal counsel to assure that the report is factual, that it reflects management philosophy and that it is a viable legal document.

Step five includes post-report activities, such as additional data collection and monitoring, research and testimony at public hearings.

Because the project team may be composed of as many as twelve investigators, it is necessary that they interact with each other in an interdisciplinary manner. Each investigator provides input to others, and in turn, utilizes their conclusions in the preparation of his analysis.

It is incumbent that the project team do more than just analyze and describe the impact of the proposed action. Perhaps the most important aspect of the analysis is to recommend alternate courses of action that would substantially reduce environmental impact.

Developments and Environmental Protection: J. P. Parkinson

One of the biggest problems facing those of us who are involved with protection of the environment is reaching rational decisions that are free of pure emotion. In other words, doing the right thing when our activities pose threats to the environment and the ecosystems. It is not my desire to get into the classic semantic discussion at this time because I would be quickly overwhelmed and my day would be spoiled. Therefore, as an engineer, I am going to exercise a degree of literary license in the use of the terms environment, ecology and ecosystems and hope you will understand and bear with me for the next few minutes.

Environmental protection is still a subjective business. It is an emerging science but is still in the art stage and, therefore, I believe we have to think about it in a special way. First, we must not lose sight of the fact we are dealing with life processes and life itself. Second, we are never going to be able to quantify everything we would like to, nor are we going to be able to make all of the positive assessments we should. These facts, coupled with the general lack of an appreciation by the public at large of environmental facts and ecological phenomena, present us with a very difficult task--to make the right decisions with respect to protection of the environment and the life and life processes that are dependent on it.

I will try to express some of my thoughts on the process of presenting environmental protection information to decision makers so they will be able to make the right decisions. It is a process that needs a great deal of refining but I think the basic concepts are sound.

We live in a dynamic system of ever changing environmental conditions and interrelationships among the living and non-living things. Man himself is a part of this system and as long as we are careful not to alter the natural rate of change of the environment things will go fine. Evolution of living organisms has kept pace with the natural rate of change. Those species that could not keep up with the pace became rare and endangered species and eventually became extinct. A classic example is the dinosaur which, because of "over specialization" and experiment in the wrong direction, could not keep up with the changing environment.

Man has the capability to accelerate the rate of change of the environment and to upset the sensitive interrelationships among the living things in a manner that exceeds the evolution rate for some of them. Dodos could not learn to distrust man soon enough to escape extinction at his hand. As a result of man's activities the Atlantic salmon has been displaced from the Great Lakes drainage and is being displaced in many formerly productive rivers along the Atlantic coast. We have nearly succeeded in getting rid of the whooping crane and except for "band-aid treatment" would have been successful before now. The passenger pigeon is gone.

I submit that we not not want to be responsible for any new and avoidable ecological crises. We cannot do anything about the dinosaur type of situation but we certainly can for the dodo type of situation. We must control our activities so that unnatural rates of change are not forced onto the environment.

In fifteen years of experience trying to protect the environment, and thereby protect the dependent species, one point needing a great deal more attention has been clearly identified in my mind. That is the question of presenting the environmental facts to the decision makers in such a way that they can grasp the relevance of what is before them. They have no difficulty with economics and engineering but when it comes to environment--that is something else. I think we have to look at what people already understand for clues as to how we can help them obtain a firmer understanding of the environmental facts. Two concepts seem to me to be worthy of examination in this regard--significant figures and safety factor.

I will toss out my ideas and if the suggestions are any good I would hope they will be picked up and refined by more able people. I do not preclude the use of systems analysis and computers but I caution very strongly against over reliance on these tools at our present state of the art because we must make too many subjective guesses with

respect to quantifying many key parameters in the equations. In many cases, our assumptions about biological "variables" may not be correct.

Significant Figures

In almost anything we want to quantify there will be errors of measurement. As we refine our measuring techniques the errors become smaller. When we put a number of measurements together we have cumulative errors entering the picture, some tending to cancel others, but in the end we cannot rely on our answer being accurate to the precision of our finest measurement. We are not concerned with significant figures. There really is not much point in measuring one dimension to the nearest "ten thousandth" and a related one to the nearest "one thousandth" then quoting the answer to the nearest "ten thousandth." This becomes even more ludicrous when we are measuring apples and oranges or vegetation and fish. Let us then concentrate on significance when we are planning and implementing our environmental protection investigations and not on magnitude alone.

When we are dealing with ecological systems we need continuing fundamental research to identify relationships that will enable us to select the significant and essential parameters to investigate when we are faced with an environmental protection problem. When such problems arise we cannot afford the luxury of initiating fundamental research. We must produce the best advice possible in the time available knowing we do not have all of the answers in the detail we would like. In other words, we select key parameters to investigate only in sufficient depth to give us our direction for our control efforts.

Safety Factor

Engineering design is a pretty cut-and-dried process. Engineers work with materials that are selected within fairly narrow limits of quality, such as lumber, or fabricated to provide specific characteristics, like steel. Thus, they can design and build with a reasonable degree of assurance that their structures will perform properly. You don't find engineers taking chances though! They apply a safety factor to look after the variation in the timber that went undetected, the variation in quality control during fabrication of the steel beam, or mixing of the concrete, or the unexpected soil condition that didn't show up in the drilling program, or unexpected loads beyond design capacity. Yet, they still have failures.

My point is that we must start expressing ourselves in similar ways when we are producing advice and recommendations to the decision makers. To my way of thinking, significant figures and safety factors offer excellent potential for successful expression of the case for the environment, the life processes and inter-relationships.

In my simple way, I visualize two curves to help me rationalize what environmental protection is all about. I don't claim authorship for either one--only adaptation.

"Time-Environmental Change" Curve

The first curve depicts environmental change over time. Through the normal course of natural processes, there is a steady rate of change that evolution and adaptation can keep pace with. Occasionally, some major event occurs which causes a sharp increase in the rate of change. Lush tropical swamps may rise and become elevated semi-arid plains, whole regions may subside, volcanoes may erupt. At such times some species may become rare and disappear.

Man does not have much control over these natural changes, but not all of the irregularities on the "time-environmental change" curve are natural. Man dams rivers, builds highways, farms vast regions, mines for minerals, pollutes waters and so on. These are the places we must exercise control over our activities.

"Activity-Environmental Change" Curve

The irregularities on the "time-environmental change" curve result from the cumulative effects of many individual causes. How can we arrive at some quantitative assessment of the effects of the individual causes? The problem is monumental and I don't have the answer, but to further help me in a quasi-quantitative way, I visualize a second relationship which I call the "activity-environmental change" curve. Again, in my simple way, I rationalize that for any given activity, the environmental change is likely to be some function of the intensity of the activity and the ecological effects will likely be influenced in a similar way. For any activity we should be able to develop a nice, well-defined curve for each environmental parameter. For each activity then, there will be a whole family of curves--one for each parameter--and it is doubtful that they will all be the same shape. Therefore, instead of a nice, well-defined curve for each activity, we have a wide "fuzzy" curve.

The curves are likely to have one characteristic in common, though. Somewhere there will be a "danger threshold" level of activity intensity where the curve will take on an exponential shape so that for any increase in activity intensity, there will be a disproportionately larger increase in environmental change. It is unlikely that the threshold level will be the same for each parameter so we end up with another wide "fuzzy" area marked off as the "danger threshold" level.

We are unable to quantify our parameters in all cases, so we must make subjective judgments based on our best knowledge, experience and intuition. This adds a grey area around our already "fuzzy" curves.

We must now somehow apply our safety factor to control the environmental change within acceptable bounds. We apply this to the intensity of the activity so that the "danger threshold" is not crossed, thus causing trouble for the critical parameter.

When we have studied the individual key activities and parameters, defined their "danger thresholds" and "grey areas" and compiled the data into composite "activity-environmental change" curves, we can then proceed to synthesize the "time-environmental change" curve. If we, as environmentalists and ecologists, have done our work right and the decision makers do their jobs right, then the actual "time-environmental change" curve will have a minimum of irregularities.

It is conceivable that the curve could have "steps" followed by the original rate of change of the environment, or by some new rate of change characterized by a change in the slope of the curve. It is also conceivable that the curve would have a "hump" indicating some or total restoration of the environment. Our task of environmental protection is to minimize the "humps", "steps" and change of the slope of the subsequent part of curve.

Let us ponder for a minute the number of activities that go into building some major work such as a pipeline in our North. Think about the number of parameters that must be considered, the number of individual environments, the number of individual species and our general inability to quantify everything the way we would like to be able to. We now begin to get some idea of the magnitude of the problem. Obviously, we will never have the entire answer. We must use our knowledge, training and experience with the utmost integrity to select the key parameters and activities for study and control to gain the greatest benefits from our time and money.

How do we really apply safety factors and significant figures to environmental protection?

We apply the significant figure concept by making a meaningful selection of the key parameters and activities then investigating each of them in the depth necessary for the problem at hand. We must avoid making every environmental protection investigation an excuse for a detailed research project. Continuing research does, however, have its place in identifying the key parameters for environmental protection investigations for specific problems and must be encouraged for this reason on an independent basis.

We apply the safety factor concept to the control of activities such as route selection, digging trenches, driving over the tundra, working in bird sanctuaries, wastes disposal and use of pesticides and herbicides and so on. Without the proper application of the safety factor we may create "steps" that some species cannot

tolerate and we lose them, or we destroy some unique natural or archeological site, or we may increase the rate of environmental change sufficiently to preclude adaptation to the changing situation by some species and we lose them through attrition. We see the latter illustrated very dramatically in some of our salmon rivers and wildlife areas when dams are built or when land is cleared for agriculture and other purposes. On the other hand, environmental change can be beneficial to some species. Deer thrive in many logged-over areas. Obviously we must consider the positive effects as well as the negative ones.

From the environmental protection point of view we cannot compromise the safety factor. We must stick with the safe level of protection. It is our responsibility to present as complete and objective a picture as possible of the environmental and ecological side to the decision makers so they do not have any excuse for not doing their jobs properly. In the decision making process environmental protection must be considered on equal footing along with engineering, economics and social factors. This is not simple so save a little sympathy for the decision maker because no matter what he does someone is not going to be happy. Developers will think the decisions and controls are too restrictive while the "natural hygenists" will charge "sell out." Both may be partially correct but, until we can quantify in realistic terms, the only safe course is to err on the restrictive side.

Environmental and ecological protection is going to cost money. We will have to do things differently in the future than we used to do them. Innovation will have a high priority. We can have our developments and healthy environments with healthy, viable ecological systems if we exercise restraint in our activities. This is the price we have to pay and we better get used to it pretty quickly. We are not protecting the environment only for the ducks, geese, fish, caribou, ipswitch sparrows and so on. They are only indicators of how well we are doing the job of protecting the environment for ourselves.

Some Legal Viewpoints on the Problems of Environmental Impact Assessment: John L. Dewar

<u>Question 1</u>

What are the administrative and procedural limitations of the "environmental impact statement approach" for ensuring better project design and lessening environmental disturbances?

Answer

I suppose the most basic limitation lies in the type of legislative scheme employed. N.E.P.A. sets out a statement of national environmental policy and then directs "all agencies of the Federal Government" to implement this policy "to the fullest extent possible." Of necessity Section 102 is worded in a broad general manner because it is intended to apply to a diversity of activities (e.g., the T.A.P.S. programme; the civil supersonic aircraft programme; the use of chemical defoliants).

The Federal agencies have now issued guidelines which analyse the five topics required to be covered in the environmental impact statement (E.I.S.) and attempt to be more specific than is Section 102 (2) (c) as to the type of information required. However, experience to date has shown that the different Federal agencies have not been consistent in implementing the national environmental policy, either as to when they file the environmental impact statements or as to what sort to information they include. It seems that different agencies have different views as to what constitutes adequate consideration of environmental consequences.

I think it's fair to say that in the absence of some sort of "watch-dog agency" (which the Council on Environmental Quality is not, but perhaps should be) the effectiveness of N.E.P.A. depends largely on how much the affected agencies want to make it work. To date, some of the agencies seem to have attempted a minimal compliance with the legislative requirements--i.e., they've treated N.E.P.A. as something which gets in the way of getting the job done, rather than regarding consideration of possible adverse environmental consequences as part of their job. It is the sort of attitude for which the U.S. Court of Appeals recently reprimanded the Atomic Energy Commission in the case of Calvert Cliff's Co-ordinating Committee v. United States Atomic Energy Commission, (1971) 449 F.(2d) 1109 at 1111- 1112.

In that case the Court of Appeals indicated that the role of the judiciary was to ensure strict compliance with the requirements of N.E.P.A. This raises another problem, more acute in Canada than it is in the U.S., viz, how to bring before the court an agency which you feel has not lived up to the legislative requirements. In legal terms, in order to bring a suit, you must show that you have "standing"--i.e., that you have some direct personal or economic interest which you are seeking to protect by bringing the suit. (Example given of private person attempting to stop the building of a northern pipeline.) In the U.S., as a result of several recent decisions, the doctrine of standing is more liberal than it is in Canada, and in certain cases conservationist organizations have been granted standing on the basis that they had a special interest as evidenced by their activities in the field of environmental conservation. That is how the conservation societies were able to obtain an injunction in relation to the T.A.P.S. project.

Other difficulties in the wording of N.E.P.A.:

(a) It is not clear at what stage or stages of a particular project the environmental implications must be assessed. As I understand the matter this is presently left to the determination of the particular agency involved.

(b) Clarification seems to be needed regarding the filing of supplemental environmental impact statements to take account of changed circumstances.

Conclusion: The limitations mentioned are not insurmountable. I think that legislation along the lines of N.E.P.A. would be most desirable in Canada. See further, the answer to question 3.

Question 2

Are there procedural barriers that prevent input of environmental protection criteria at the appropriate times? For example, is the sequence of administrative events before various approving, licensing and appeal bodies such that resource development decisions are normally irrevocably made before environmental protection needs can have a bearing on the decision?

Answer

One procedural barrier which you may run into before the administrative agencies as well as before the courts, is the requirement of "standing," which I've already mentioned; e.g., the adminstrative agency may take a very strict view of whether or not you are an "interested person." (Reference to Section 45 of the National Energy Board Act (R.S.C., 1970, c. N-6). A further problem is that even assuming you do get to be heard you may not be able to ensure that the information you supply will be given due weight, having regard to the entrenched attitudes of the particular agency. (Reference to Section 44 of the National Energy Board Act).

See further, the answer to Question 3.

Question 3

Are current practices and statutory provisions in respect to disclosure and access by interested persons to government experts or information adequate to allow effective environmental protection during resource development projects?

Answer

My answer is that current statutory provisions are not adequate because they do not take the matter far enough. We need more than provisions for disclosure and access; we need a legislative scheme

which imposes a duty on involved parties to give adequate consideration to environmental implications, and makes them answerable in Court if they do not.

One possibility is legislation along the lines of N.E.P.A., which sets out a national environmental policy and then charges government agencies to implement that policy to the fullest extent possible. If legislation of this type were introduced in Canada, provision would have to be made to broaden the doctrine of standing. (See Question 1.).

Even with such legislation there would remain the problem of ensuring it has teeth in the face of a national policy which overwhelmingly supports economic growth and technological development. The problem is that governmental agencies, while charged with the responsibility of implementing a national environmental policy might nevertheless tend to minimize the importance of environmental considerations by employing a cost benefit analysis which concludes that the public should be subjected to some environmental detriment or risk which in the opinion of the agency is "tolerable" in exchange for more obvious economic or material benefits. We've seen the emphasis which is placed on economic considerations under Section 44 of the National Energy Board Act. We've also seen the attitude of the Atomic Energy Commission in the Calvert Cliff's Case.

One writer has described the problem as an "information gap": our technological advances have outpaced our knowledge of the possible risks and adverse consequences of the application of that technology; nevertheless we tend to overstate its possible benefits and minimize the possible costs in terms of environmental degradation to avoid retarding "development."

A possible solution here, were we to introduce legislation along the lines of N.E.P.A., would be to enlist the assistance of the Department of the Environment by changing its role from that of an advisory body for other government agencies into a sort of "watchdog agency." It could be given a general mandate to find out and publicize the potential adverse environmental consequences of any proposed activities, and make this information available even to persons who wished to challenge the activities of another government agency. Alternatively, the Department could be given the power to veto proposed activities of other government agencies on the ground that such activities did not comply with the stated national environmental policy.

WORKSHOP: THE ROLE OF MICROORGANISMS IN THE EPIDEMIOLOGY OF BARK BEETLES

Moderator: H. S. Whitney

The workshop was introduced by a brief consideration of the occurrence and possible roles of microorganisms associated with bark beetles.

Staining and nonstaining filamentous fungi and yeasts plus bacteria, nematodes and mites are common associates of many *Dendroctonus*, *Ips*, and *Scolytus* species. It was noted that mycoplasms, viruses, viroides and protozoans ought to be found from time to time but little or no information was available on these microorganisms affecting bark beetle populations.

The roles microrganisms might play in bark beetle epidemiology were considered under the headings mutualistic symbionts, either nutritional or physical, pathogens to the beetles, and, assuming a mutualistic relationship with blue stain fungi and or yeasts, then pathogens to the fungal symbionts (mycoparasitism) would become significant. Finally microorganisms were considered as host tree pathogens resulting in predisposition of the host.

Testing of an hypothesis, that the blue stain fungi *C. montia* and *Europhium clavigerum* and/or the yeasts *Pichia pini*, *Hansenula capsulata* and *H. wickermanii* are nutritionally mutualistic with the mountain pine beetle (mpb) on lodgepole pine, was described. The approach was to compare axenically reared beetles with and without yeast and fungi in their diets. Study of the specific fungi named was based on their universal association with m.p.b. despite the beetle's frequent encounter with other microorganisms. Also the occurrence of these microorganisms in the m.p.b. mycangium attested to their close association with this insect. Axenic m.p.b. adults in the laboratory remained brown in the absence of yeast or fungi in their diet. Brown axenic parents produced normally appearing offspring except that they were brown.

A discussion proclaimed the need for carefully selected parameters in studying nutritional and other physiological factors affecting insect survival and fecundity, especially when relating laboratory results to phenomena in the forest.

Testing the hypothesis, that axenic mpb were less successful in overcoming host resistance than were fungus re-contaminated axenic beetles, was hampered by variability in host resistance and the inability to select suitable study trees. Attempts have been made to reduce host resistance so that performance of axenic and re-contaminated axenics could be compared in the field. A "u" shaped chain saw cut 1-2" deep and 2" wide made vertically on the stem produced a localized zone of

tissue that graded from completely resistant to non-resistant. Preliminary results were that m.p.b. with microorganisms advanced further into the resistant tissue than did axenic m.p.b.

A promising technique for controlling tree stress and therby investigating some of its effects on insect attack was outlined. The method was to temporarily cool or freeze the tree stem during the mid-growing season and thereby create a reversible and controlled stress in the tree. A 2-3 foot section of tree stem was wrapped with tubing through which was pumped a refrigerant. Cooling was measured with thermocouples in the sapwood. Several measurements of tree response to cooling were made. In general as the stem section cooled (finally to -15°F) sap flow (Heat Pulse Velocity) declined to a low level, water stress (Scholander bomb) increased in the crown, oven dry moisture of sapwood above the cooled zone became less, and stem diameter decreased slightly. Phloem and sapwood parenchyma cells, though changed, were apparently undamaged by the cooling treatment. In preliminary tests on 4 trees, female m.p.b. caged onto trees that had been cool-stressed 2 days produced typically successful appearing egg galleries, i.e. non-resinous dry frass. By 1 to 2 days after stress was relieved these beetles were pitched out by a copious flow of resin. It is anticipated that this sort of technique will enable an experimental approach to ascertaining the role of microorganisms in the successful establishment of bark beetles in their host trees.

It was reported that fresh cut and waxed grand fir bolts had to age approximately 3 weeks before *Trichosporium* sp. associated with *Scolytus ventralis* would grow well in these bolts. Most. *S. ventralis* attacks initiated before this time aborted because of resinosis. There was considerable discussion as to why *S. ventralis* was not as "good" as inoculator of fir bolts as were cultures of *Trichosporium*. The possible effects of other microorganisms carried by *Scolytus ventralis* was discussed.

WORKSHOP: WORKING TOWARD AN IDEAL RELATIONSHIP BETWEEN ECOLOGISTS AND TAXONOMISTS

Moderator: H. R. Wong

It was noted that ecological studies are based on systematics and good systematics is also ecologic. The unity of these two fields, however, has not generally created an atmosphere of mutual understanding and appreciation. After expanding upon the more common of the many criticisms made by both the ecologists and taxonomists, the meeting was open for discussion.

The taxonomists felt that ecologists were not always aware of the procedures and practices followed in systematic studies. Because of these procedures and practices some well established names are changed, and lumping and splitting of species and genera occur. Taxonomists generally are responsible for the identification of a large group of animals or plants and can only specialize in a small group. Because of the considerable amounts of service work, they are called upon to do, the lack of revisionary works, and time for basic research, taxonomists can often supply only generic names to many of the identifications sought by ecologists. Taxonomists pointed out that they can not only supply field ecologists with identification, but also can supply information on life history, distribution, host and other biological information on certain species. To enable better understandings of the variation and distribution of a species, taxonomists are appreciative of any material they receive for study--they stated that any ecological work is only as good as its taxonomy, and requested closer cooperation with ecologists.

The ecologists felt that some taxonomists tend to rush into print for some seemingly unnecessary name changes. They feel that taxonomists do not appreciate ecotypes and their influence on specialization and hybridization. Ecologists would like to know if different populations in different ecotypes represent different species, and the variation and distributional limits of a species. The ecologists felt that taxonomists should spend more time in the field to get better appreciation of the ecology of the groups they are studying.

The workshop closed with consensus that ecologists and taxonomists should work more closely together, and that far more financial support should be available for these two disciplines.

WORKSHOP: CLIMATIC EFFECTS ON INSECTS IN THE BOREAL FOREST

Moderator: J. S. Hard

Qualitative studies of mountain pine beetle populations in Canada suggest that one of the major effects of winter mortality is greater average adult size for both sexes, a greater female to male sex ratio, and greater reproductive potential.

Preliminary analyses show that the forest tent caterpillar in Canada can better withstand adverse weather during initial stages of an outbreak than during final stages. Unless extreme, high summer and low winter temperatures are not an important mortality factor. However, population crashes have coincided with unusually cold springs after larvae have hatched, although larval mortality was apparently caused primarily by dislodgement and starvation.

Analysis of two recent black-headed budworm outbreaks in Southeast Alaska revealed a significant relationship between acres of forest defoliated in a given year and mean temperature of (a) the mating and oviposition period the previous year, and (b) the larval period in the year that the defoliation occurred. This mean temperature, or Temperature Index, has a long-term mean of 53.2 degrees F. in Southeast Alaska. Defoliation by the budworm increased in years with Temperature Indices above the long-term mean, and decreased in years with Temperature Indices below the long-term mean.

Evaluation of the accuracy and precision of the sine function for calculating heat units showed (a) that it is fairly reliable for estimates over an extensive area, (b) the precision of the estimate generally decreases with increasing base temperature, and is affected by seasonal variation in the general shape of the temperature curve, and (c) for individaul stations the sine function consistently under or overestimated actual heat units by as much as seven percent. A new formula,

$$Y = b \; {\frac{\text{Max} - \text{Th}}{\text{Max} - \text{Min}}}^{c} \; (\text{Max} - \text{Min}),$$

gave unbiased estimates of heat units on both single and combined station basis and had a precision about 11 percent greater than the sine function. It has the additional advantage in that it can be fitted by the method of least squares.

WORKSHOP: AERIAL PHOTOGRAPHY IN FOREST PEST SURVEYS

Moderator: W. M. Ciesla

Color and false color infrared aerial photography has gained wide acceptance as an operational tool for gathering data on the distribution and abundance of damage caused by forest insects in both the United States and Canada. Three papers describing operational uses of color aerial photography and research and development of other airborne sensors and space imagery for mapping areas of damaged vegetation were presented. Applications included detection of vegetation damaged by insects, diseases, and atmospheric pollutants. Synopses of these papers are included in this section.

Discussion followed on potential uses of space imagery for mapping large areas of vegetation damage particularly with reference to NASA's upcoming ERTS and SKYLAB programs. The application of multistage sampling using combinations of space photography, high altitude aerial photos, large-scale photography, and ground sampling was also discussed.

Color Aerial Photography for Mapping Douglas-fir Beetle Infestations in Northern Idaho: F. W. Honing and W. M. Ciesla

The Douglas-fir beetle, Dendroctonus pseudotsugae Hopk., is a serious insect pest of Douglas-fir, Pseudotsuga menziesii var. glauca (Mirb.) Franco, the most valued commercial tree species in the Northern Region. This insect periodically reaches epidemic levels, usually following a natural disaster such as severe windstorms or ice storms which provide large volumes of breeding material in the form of damaged timber. Beetles normally invade this material, reach epidemic proportions, and attack standing green trees the following year.

A massive infestation of the Douglas-fir beetle was discovered in Douglas-fir forests of the North Fork Clearwater River drainage in northern Idaho during 1971. Aerial reconnaissance surveys conducted by the Clearwater-Potlatch Timber Protective Association established the infestation boundaries to be the lower North Fork from Dworshak Dam to the Canyon Ranger Station of the Clearwater National Forest, with heavy concentrations of beetle activity occurring in Meadow and O'Neill Creek drainages and on the slopes of John Lewis Mountain. The infestation apparently reached epidemic proportions in 1970 but was not detected until a year later when infested trees began to fade.

Factors which may have contributed to a buildup of Douglas-fir beetle populations in the area are believed to be:

1. Ice and snow breakage that occurred in Douglas-fir stands during the winter of 1968-1969, which provided an abundance of breeding material.

2. Land clearing activities associated with the construction of Dworshak Dam on the North Fork Clearwater River which resulted in considerable volumes of green Douglas-fir slash.

3. Extensive stands of Douglas-fir in the North Fork Clearwater River drainage which are susceptible to Douglas-fir beetle attack.

An evaluation of this infestation, using aerial photographic and ground survey methods, was conducted during August 1971. This evaluation was a cooperative effort involving forest land managers from the Idaho Department of Public Lands, Potlatch Forests, Inc., Clearwater-Potlatch Timber Protective Association, Corps of Engineers, Bureau of Land Management, Intermountain Forest and Range Experiment Station, Clearwater National Forest, and entomologists from the Division of State and Private Forestry.

SURVEY METHODS

Impact survey.--Double sampling with regression was used to estimate:

1. The number of trees killed by Douglas-fir beetle in 1970.
2. The volume loss caused by Douglas-fir beetle in 1970.
3. The number of trees killed by Douglas-fir beetle in 1971.
4. The volume loss caused by Douglas-fir beetle in 1971.

This consisted of a large aerial photo sample corrected by a small ground sample (Wear, et al. 1966).

A series of 100 100-acre aerial photo plots was established in a systematic grid pattern over the 288,000 acre-area of infestation. Photo missions were flown in mid-August at a scale of 1:7920 (8 inches = 1 mile) by the Division of Engineering, U.S. Forest Service, Missoula, Montana. Film-filter combination was Ektachrome infrared Aero (type 8443) with a Wratten G filter. A 9-inch format Ziess-RMK/A aerial camera equipped with a 6-inch focal length lens was used for the photography. Stereo pairs (60 percent overlap) were taken at each plot location.

One hundred-acre photo plots; 20 x 50 chains, were located within the stereo overlap portion of each photo pair. These plots were examined stereoscopically with an Old Delph scanning stereoscope by two photo interpreters working independently. Each photo interpreter made a detailed count of the number of Douglas-fir with discolored crowns in the plots. Care was taken to separate western white pines, *Pinus monticola*, killed by either white pine blister rust, *Cronartium ribicola*, or mountain pine beetle, *D. ponderosae* Hopk., and grand fir, *Abies grandis*, killed by fir engraver, *Scolytus ventralis* Lec., from trees killed by Douglas-fir beetle. Criteria used for separating discolored Douglas-fir crown from discolored crowns of other tree species was the crown form of the host trees; Douglas-fir is a full-crowned species whereas both western white pine and grand fir have considerably narrower crowns. In addition, Douglas-fir beetle infestations generally occur as group kills as opposed to the other insect and disease agents common to the area which occurred more often as scattered single-tree attacks.

Twenty-six of the 100 photo plots were randomly selected for ground sampling. A variable plot cruise was conducted in each of these plots using a relaskop (BA = 20). Subplots were established at 5-chain intervals on cruise lines 5 chains apart for a total of 40 subplots per photo plot. Each tree occurring in a subplot was recorded by species, d.b.h., and total height, and was classified into one of four tree classes:

0 - green, uninfested
1 - attacked in 1971; green foliage, brood in cambium
2 - attacked in 1970; faded or red foliage, brood emerged
3 - snaps, attacked prior to 1970

Resultant data was analyzed by a modified ADP sale cruise program which provided summaries of infestation levels, volume losses by year, and residual stand composition for each plot ground cruised. Four variables--1970 trees, 1970 volumes, 1971 trees, and 1971 volumes--were used as the dependent variable "y" and the photo count of discolored trees was the independent variable "x" in the regression analysis.

RESULTS

Air currents occurring over the survey area at the time of the photo mission caused the survey aircraft to drift from time to time. This altered the pattern of aerial photo plots from a systematic grid to a quasi-random configuration (Fig. 1). Color patterns of discolored crowns due to Douglas-fir beetle infestation on Ektachrome infrared Aero film were comparable to those described for southern pine beetle <u>Dendroctonus frontalis</u> Zimm., in the southeastern United States (Ceisla, et al. 1967). Red-topped and fading Douglas-fir appeared as a yellow to beige color and older kills, which had lost their needles, registered as blue-green to gray.

Summaries of photo interpretations by the two independent interpreters were quite similar. Both sets of "PI" data were correlated with ground survey data in order to obtain F ratios for slope and the correlation coefficient "r." The F ratios of the regressions were significant at the 99 percent level for all four dependent variables for the second PI. The F ratio for the regression of 1971 volume loss over 1970 attacks was significant at the 95 percent level for the second PI. Correlation coefficients (r) were high (over 0.80) for three of the four dependent variables for both photo interpreters with relatively poor correlation occurring for the regression of 1971 volume loss over 1970 attacks (0.512 and 0.494). F ratios and correlation coefficients were slightly higher for one PI; therefore, this data was used to prepare estimates of tree and volume losses (Fig. 2).

Aerial photo estimates corrected by ground surveys indicated that a mean infestation level of 0.2379 Douglas-fir per acre resulting in a volume loss of 123.75 board feet per acre occurred in 1970. In 1971, infestation levels increased to 0.3684 trees per acre with a resultant volume loss of an additional 177.75 board feet per acre. Total loss for the 288,000-acre survey area is estimated at 68,515 trees and 34,640,000 board feet in 1970 and 106,099 trees and 51,195,000 board feet in 1971. The ratio of 1970 to 1971 attacks was 1:1.5; however, the size of tree attacked was somewhat smaller in 1971 than in 1970 (Table 1).

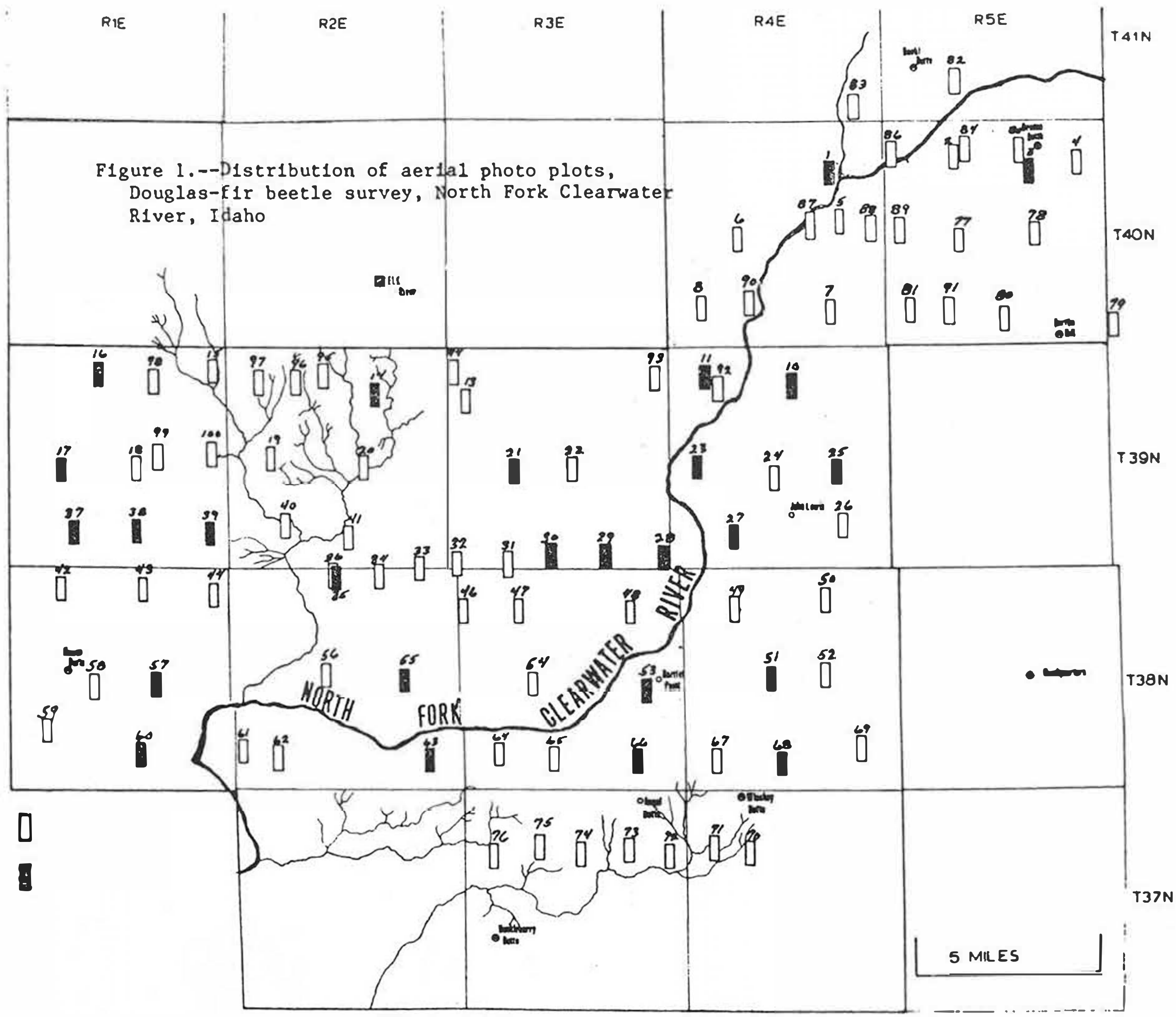


Figure 1.--Distribution of aerial photo plots, Douglas-fir beetle survey, North Fork Clearwater River, Idaho

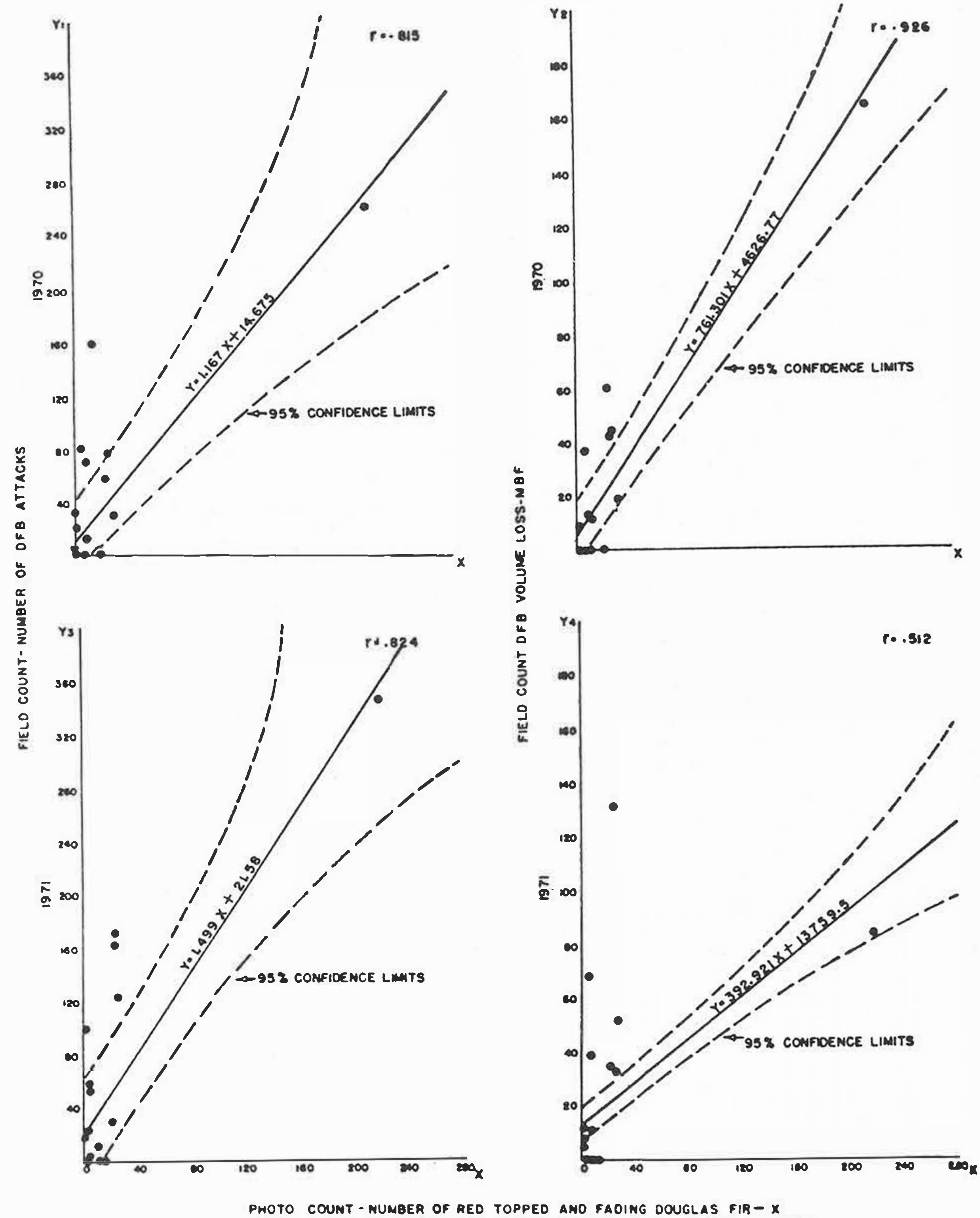


Figure 2.--Linear regression of field counts over photo counts.

Table 1.--Estimated losses by Douglas-fir beetle North Fork Clearwater River - 1970-71.

	1970	1971	Total
Trees/Acre	.2379 ± .086 1/	.3684 ± .108	.6063
Volume/Acre (bd. ft.)	123.75 ± 40.94	177.75 ± 35.38	301.50
Total trees 2/	68,515 ± 24,734	106,099 ± 31,087	174,614
Total volume 2/ (MBF)	34,640 ± 10,465	51,195 ± 10,290	85,835
Volume/infested tree (bd. ft.)	520	482.5	491.6

1/ 1 S.E.

2/ Based on a gross area of 288 M acres in the survey unit.

LITERATURE CITED

Ciesla, W. M., J. C. Bell, and J. W. Curlin, 1967. Color photos and the southern pine beetle. Photogrammetic Engineering XXXIII (8):883-8.

Wear, J. F., R. B. Pope, and P. W. Orr, 1966. Aerial photographic techniques for estimating damage by insects in western forests. USDA Forest Service, PNW Forest and Range Experiment Station, Portland, Oregon.

Aerial Photographs in Forest Pest Surveys in Canada: P. A. Murtha

Even though aerial photographs had been occasionally used in forest pest surveys for several decades in Canada by the Canadian Forestry Service, it was not until 1968 that use of aerial photographs for forest damage pest surveys received increased attention. Such attention was directly attributable to developments in high-speed, fine-resolution, aerial color film emulsions. The purpose of this note is to describe some of the recent developments in the use of aerial photographs in forest pest surveys.

PHOTO INTERPRETATION OF FOREST DAMAGE

To avoid duplication of research studies, and to provide those persons interested in the photo interpretation of forest damage with a foundation to carry out air photo surveys, a "Guide to the Aerial Photographic Interpretation of Forest Damage in Canada" has been prepared (Murtha 1971a). In the Guide, forest damage is defined as any type and intensity of an effect, on one or more trees, produced by an external agent that temporarily or permanently reduces the financial value, or impairs or removes the biological ability of growth and reproduction, or both. For purposes of photo interpretation, forest damage is divided into four major types, based upon morphological or physiological characteristics recorded on aerial photographs.

The morphological characteristics are mainly degrees of defoliation or deformation of the tree, whereas the physiological characteristics involve changes in foliage color, or in non-visible near-infrared reflectance. The four basic forest damage types, as they appear on aerial photographs, are:

Type I Damage:	Trees that appear completely defoliated;
Type II Damage:	Trees that show some defoliation through the presence of bare, or partially bare, branches, or are deformed;
Type III Damage:	Trees that show foliage a color inconsistent with normal foliage color of the species;
Type IV Damage:	Trees that have a deviation from their normal reflectance pattern in the non-visible light spectrum, with such deviations recorded by near-infrared sensitive film.

The four damage types are subsequently divided into 31 damage syndromes,[1/] identified by means of a key. Type I damage has five distinct syndromes. Type II damage has eight syndromes and is frequently found in combination with the 17 Type III damage syndromes. The two Type IV syndromes are generally not found in combination with other syndromes on the same tree. One damage agent may cause several damage syndromes, depending upon the stage of damage, and conversely, one damage syndrome may be caused by several agents (Murtha 1971b), hence the need for ground checking to positively identify the cause. However, deductive reasoning by the photo interpreter can provide a good estimate of damage cause.

Thus it is well established that most, if not all types of forest damage, if recorded on aerial photographs, can be interpreted. The major premise, when photo interpretation of forest damage is considered, is that the damage has affected the morphological or physiological character of the tree to such an extent that the damage is recorded by one or more photographic films when exposed with the appropriate filter(s) and the photos are taken at a scale large

enough to record the damage syndromes. The second premise, is that the photo interpreter is familiar with the damage syndrome(s) and thus knows what to look for on the photos.

FOREST DAMAGE APPRAISAL

After forest damage has been detected, the problem is to appraise the extent and intensity of the damage. Air photo damage surveys may or may not include a volumetric estimate or some other form of current value assessment of the damage. In either case, a photo interpreter's map provides the exact location of the damage, and a relative, or "eye-ball" estimate of the damage intensity. Two cases studied are described below which provide generalities for both types of air photo damage surveys; emphasis is placed on the photo interpretation methods used rather than on air photography specification or an analysis of the results.

Case No. 1 - SO_2 Forest Damage Delineation[2/]

In this study, ultra-small-scale (1:160,000), color infrared aerial photographs were used to delineate four forest damage zones which resulted from SO_2 air pollution. It was known from aerial sketch mapping that the SO_2 which came from an iron sintering plant had affected vegetation over approximately 350 square miles. The purpose of the photo interpretation was to delineate and map damage zones on the ultra-small-scale photographs. A volumetric estimate of the timber loss was not considered in this case.

The photo interpretation procedure involved a preliminary field check to familiarize the photo interpreter with the ground situation, and to establish criteria for damage zone delineation, which could be used during interpretation. The criteria, given in Table 1, were based upon damage to the most SO_2- susceptible tree species, white birch (*Betula papyrifera* Marsh), and on the effect of SO_2 on the total forest composition.

During interpretation, it was found that the damage zone descriptions (Table 1) were suitable to delineate the SO_2 fume damage.

1/ Syndrome, according to Webster, is "a group of signs and symptoms that occur together and characterize a particular abnormality."

2/ The complete study has been described by Murtha, P. A., 1972. SO_2 forest damage delineation on high-altitude photographs. Proc. 1st. Can. Symp. Remote Sensing. (In press).

However, although it was possible to delineate the four damage zones on the color infrared photograph, at no given time was it possible to attribute the damage solely to SO_2 fumes. The overall syndrome of damage, ranging from total kill to light injury, could also be ascribed to other types of air pollution as well as SO_2 fumes. However, in this case the cause of damage was known.

Table 1.--Criteria used for photo interpretation of SO_2 fume damage in Northern Ontario from ultra-small-scale photographs

Total-kill	Almost all vegetation is absent, rock outcrops and landforms are prominent, no observable tree growth.
Heavy-kill	Almost complete mortality of all trees; lesser vegetation predominates and a few scattered, stunted trees, shrubs and rock outcrops are present.
Medium-damage	Heavy white birch mortality (greater than 50 percent); no signficant mortality of hardwoods or conifers. There is significant foliage discoloration[1] of residual birch. Occasional pockets of dense hardwood sapling growth.
Light-injury[2]	Light birch mortality and some discoloration of birch foliage, and yellowing of old-growth white pine.

1 Foliage discoloration of birch takes place after fume damage; the leaves appear to take on a yellow cast, even though portions of the leaves have been killed and turned a light straw brown.

2 Outside the light-injury zone, early foliage discoloration attributable to fume damage does not occur.

The interpreter easily recognized the total-kill, the heavy-kill, and medium-damage zones. The outer perimeter of the light-injury zone was the most difficult to pinpoint. To aid in this boundary definition, electronic image enhancement was used. When similar white birch forest types in the damage and non-SO_2-damaged zones were compared by enhancement, it was shown that a thicker cyan-dye density existed for the damaged type than for the non-damaged white birch type. The film response apparently came from the long-term effect of SO_2 on the birch. Recurring damage had affected growth,

caused some crown dieback and, each season, premature loss of foliage. When the photos were taken on August 26, foliage abscission had occurred. The increased numbers of contained shadows within the damaged tree crown would have resulted in decreased exposure of the cyan die-forming layer of the color-infrared film. As a result, the damage birch stands were shown by the electronic enhancement to have a denser image than the non-damaged stands. On the preceding basis, it was possible to draw the approximate outer boundary of the SO_2 light-injury zone.

Predicted on interpreter knowledge, it is possible to use even ultra-small-scale (1:160,000), color-infrared photographs to delineate damage zones. The results to date have been as accurate as the results of aerial sketch mapping. The point which is emphasized here is that the photo interpreter must know what to look for, if not, even simple damage maps can become a long and tedious task.

Case No. 2 - A Spruce Budworm Damage Survey[3/]

A survey of spruce budworm damage on balsam fir (*Abies balsamea* (L.) Mill) and red spruce (*Picea rubens* Sarg.) in Fundy National Park, New Brunswick, was done using medium-scale, color-infrared photographs and ground, cluster-plot samples. The photographs were used for forest type mapping and damage classification, whereas the plot tallies served to verify the photo interpretation and to provide data for a rough volumetric estimate of the healthy and damaged timber. (Only the photo interpretation and damage classification is discussed in this note[3/]).

Color-infrared photographs which covered the entire park were taken in mid-September 1970, at a scale of 1:10,000. Color-infrared photos were taken since they would emphasize color differences between non-defoliated and partially defoliated trees and show dead trees with greater clarity than normal color photos. The scale was a compromise between economics of the study and damage detail provided by the larger photographic scales. An experienced interpreter was assigned to the task, and after a preliminary field check, a photo interpretation legend was derived. The legend included details of tree species, height class, canopy density, tree mortality and defoliation. The interpreter could identify living, partially defoliated trees from non-defoliated trees on the basis of appearance. The partially defoliated trees usually had a silvery-blue tip to the crowns whereas the non-defoliated trees did not.

3/ For a more complete analysis of the study, refer to Murtha, P. A., 1972. Spruce budworm damage in Fundy National Park. Dep. Environ., Can. For. Serv., For. Manage. Inst. Inform. Rep. Ottawa. (In Press)

At a scale of 1:10,000, pockets of damage as small as 1/10 acre could readily be recognized and delineated on the contact color prints with a 2X pocket stereoscope. The photo interpreter also had access to a zoom 240 stereoscope providing up to 30X magnification.

The photo interpretation legend was sufficient and readily applicable to type-mapping the budworm damage in the Park. The survey was an improvement over the aerial sketch mapping since it was able to pinpoint smaller pockets of damage, provide estimates of small amounts of defoliation, and used photos obtained in an "off-season" for showing budworm damage. Consequently the study has shown that spruce budworm defoliation can be mapped even after the red-brown foliage has been washed from the trees.

CONCLUSION

Recent developments in photo interpretation of forest damage and in air photo survey methods have shown that air photos can be a practical tool in forest pest surveys. A guide to the photo interpretation of forest damage syndromes has identified 31 damage syndromes which may be readily interpreted on air photos. The ones which are interpreted depend upon the type of film and filters used, and the scale of photography. Whole tree damage syndromes may be interpreted on small-scale photos, but larger scale are required to depict individual branch and leaf syndromes of damage. When the interpreter knows what to look for and how to proceed on finding various damage syndromes, a more complete determination of damage is possible.

When large areas are concerned, and damage syndromes relate to forest types, ultra-small scales (1:160,000) have been shown useful in mapping broad classes of damage to vegetation. When detailed mapping is needed for intensive management purposes, larger scales of photography are required. In the Canadian Forestry Service, color-infrared photographs were favored since color changes are emphasized. Although the acceptance is slow, the use of color photographs for aerial surveys of forest damage is making headway. In the final analysis, air photography and other remote sensing techniques will not replace present insect and disease survey methods, but they will compliment the techniques.

LITERATURE CITED

Murtha, P. A., 1971a. A guide to the aerial photographic interpretation of forest damage. Can. Forest. Serv. Publ. No. 1292. 80 p. (In press).

Murtha, P. A., 1971b. A key to the air photo interpretation of forest damage in Canada. Proc. 3rd Workshop Air Color Photogr. Plant Sci., Am. Soc. Photogramm. Falls Church, Va. p. 167-180

Remote Sensing Research Highlights, 1971-72: F. P. Weber

Remote Sensing to Detect Smog Injury to Forest Vegetation

Ponderosa pine trees in the mountains surrounding the Los Angeles basin in California are subjected to a continuous exposure of air pollutants during the active growing season. Aerial photographic techniques were developed using color aerial photography at scales of 1:8,000 and 1:1,584 to detect damage and to assess impact to forest trees affected by air pollution. Methods were developed for conducting impact surveys over broad areas using aerial color photography and a three stage probability sampling design. The number and condition of affected pine trees were estimated with a high degree of accuracy and at relatively low cost on two National Forests in southern California.

Multispectral scanning and automatic recognition processing were evaluated in the 1969 smog damage-detection feasibility study in southern California. Detection success was poor and the cost was high. Because of the random distribution of tree damage and the lack of clustering by damage classes, the scanner system tested could not spectrally classify trees into damage classes. Until substantial improvements are made in the operating specifications of airborne multispectral scanners and processors, they will not be used routinely to evaluate air pollution impact in forests.

Trend and Spread of Bark Beetle Infestations

Studies were conducted from 1968 through 1971 on the Black Hills National Forest in South Dakota on the trend and spread of *Dendroctonus ponderosae* Hopk. infestations in ponderosa pine. Within an 8-square-kilometer study area representing the high risk area of the northern Black Hills, infestations have ranged in size from a low of 96 spots in 1970 to a high of 243 in 1971. More than 7,000 trees or the equivalent of 3-1/2 trees per acre were killed in four years. During the period of study, aggregation of many small infestation spots into large area kills was a common occurrence. Results showed that spread of bark beetle infestations can be followed with 1:8,000 scale aerial photography with some double sampling on the ground. Photo interpretation and regression techniques were developed for predicting ground tree counts from photo counts.

Aerial Photos to Determine Optimum Levels of Stand Density

Field personnel in the Black Hills have long recognized the relationship between stand density of ponderosa pine and apparent stand resistance to bark beetle attack. The same relationship is seen on aerial photography. During an ongoing epidemic of *D. ponderosae* it is the dense and over-stocked pine stands which are must susceptible

to beetle attack. These same stands are frequently under some physiologic stress, such as that created by low soil moisture levels, a fact which no doubt contributes to stand susceptibility.

During 1971 a study was initiated to assist forest managers in identifying high-hazard pine stands in the northern Black Hills, and to provide data on which stands need thinning first and to what basal area the cutting should be made. The ground study involved stand density measurements in 16 noninfested stands, 22 infested stands, and 16 thinned stands using basal area and number of trees per acre as stand density criteria. Photo interpretation results revealed a positive correlation between basal area and crown closure and a negative correlation between basal area and crown diameter. Both correlations were significant at the 95 percent level. Results of the study showed no occurrence of beetle attack in thinned stands. The average basal area of infested stands was 149 square feet compared to 114 square feet for uninfested stands. The average tree diameter in the infested stands was 12.6 inches d.b.h. compared to 9.6 inches d.b.h. for uninfested stands. Preliminary results indicate that reducing stand basal area to around 100 square feet per acre increases stand resistance to bark beetle attack.

The Establishment of ERTS[1] and Skylab (EREP)[2] Earth Observation Satellite Test Sites

Beginning in 1972, forest scientists worldwide will have the unique opportunity to participate in the first earth observation satellite program. The ERTS-A/Skylab programs will be a coordinated effort by NASA to provide scientists with multispectral imagery of ERTS/Skylab test sites for orbiting satellites. The Forest Service Remote Sensing Research Unit has a participating study entitled "Inventory of Forest and Rangeland Resources (Including Forest Stress)." Because of the multi-disciplinary nature of the study, five test sites were established around the United States to accomplish the objectives of the study. The test sites are:

226A - Black Hills National Forest -- forest stress and land use
226B - Atlanta, Georgia, area -- forest inventory and change
226C - South Park, Colorado --rangeland inventory
226D - Targhee National Forest -- forest stress
226E - Stanislaus National Forest -- forest inventory

1/ ERTS - Earth Resources Technology Satellite

2/ EREP - Earth Resources Experimental Package

Our research objectives and test site locations are the same for both the unmanned ERTS-A program and the manned Skylab/EREP program. The objectives are:

1. To test the hypothesis that ERTS/Skylab data will permit identification of forest, rangeland, nonforest, water resources, and forest stress.

2. To determine the gains to be made using satellite imagery as a first level of information when coupled with aircraft underflights and ground examination in a multistage and multiseasonal sampling system for quantification of the forest related resources.

3. To compare the utility and cost effectiveness of various data and interpretation modes, such as single-channel versus multi-channel data and human interpretation versus automated interpretation, to separate and identify forest and rangeland resources.

The sensors on board the ERTS-A and Skylab satellites will provide multiple bandwidth data to earth scientists which will permit multispectral evaluation of earth objects. The sensors and associated bandwith sensitivities are as follows:

ERTS-A sensors

Return beam vidicon camera subsystem

Channel 1 - 475 to 575 nanometers

Channel 2 - 580 to 680 nanometers

Channel 3 - 690 to 830 nanometers

Multisprectral scanner subsystem

Channel - 500 to 600 nanometers

Channel 2 - 600 to 700 nanometers

Channel 3 - 700 to 800 nanometers

Channel 4 - 800 to 1100 nanometers

The ERTS-A satellite is expected to be launched in June 1972 and will provide sequential imagery every 18 days over the same nadir point on the surface of the earth.

Skylab/EREP experiments

S-190A - six band multispectral photography (30 meter resolution)
S-190B - high resolution mapping camera (10 meter resolution)
S-191 - bispectral infrared spectrometer (1 mRAD IFOV)
S-192 - 13 channel multisprectral scanner (0.182 mRAD IFOV)
S-193 - microwave radiometer/scatterometer and altimeter
S-194 - L-band radiometer

The Skylab satellite is scheduled to be launched in May of 1973 and will remain in orbit for at least one year. During the ensuing period, three groups of scientist/astronauts will man the orbiting laboratory for successive periods of 28 days, 56 days, and 56 days. Each returning group of astronauts will bring hard copies of instrument data and imagery collected from each experimental package.

During the next three years forest scientists will not only learn new information about forest resources but will certainly learn new ways to view and use earth resource information gained from space.

WORKSHOP: FUTURE OF THE WFIWC

Moderators: E. D. A. Dyer, R. W. Stark, R. I. Washburn

Prior to the annual meeting, the following letter was sent to the members of the WFIWC by Chairman Wood:

The Western Forest Insect Work Conference will hold its 23rd Annual Meeting in Edmonton, Canada, March 5-9, 1972. As your chairman and with the approval of your program chairman, Les Safranyik, I want to invite each member to participate in a reevaluation of the goals of the WFIWC, with general reference to the changing needs of our society and with specific reference to the role of forest entomology in the management of the forest resources of North America.

Many questions have been raised in recent years which motivates your leadership to make this examination a specific agenda item in the initial business meeting, to provide an intimate and free atmosphere for discussion during the conference and to formalize any recommendations that you may choose to make at the final business meeting.

The following questions have been made known to me by various members during recent years. The list is by no means complete but will serve to focus your attention on the most important question to all of us:

"WHAT IS THE FUTURE OF THE WFIWC?"

Have we insulated ourselves from the mainstream of forest resource management by the very qualities of the conference that we all enjoy, i.e., intimacy, common interests, manageability, long-term associations, etc.?

Have we been successful in advancing an understanding of forest entomology to those responsible for establishing research priorities?

Have we been successful in presenting a broader, more integrated view of forest protection that takes into account, silvicultural practice, pathology, fire protection, management and societal goals, etc.

How do we influence land management to decision making?

Do we interact with those responsible for land management decisions at the meetings they attend, i.e., Western Forestry and Conservation Association, Canada Institute of Forestry, Society of American Foresters, AAAS, AIBS, state boards of forestry, etc?

Should we not participate more broadly with scientists at such meetings as the Entomological Society of Canada, Entomological Society of America, Ecological Society of America, AIBS, AAAS, and many others, even though they are large, more difficult to manage, less intimate, etc.?

Should we not meet as forest protection specialists, including those concerned with pathology, fire, silviculture, etc.?

Do we as a group communicate effectively with our counterparts in the rest of North America?

How can we facilitate cross fertilization of the many disciplines that are needed to solve complex ecological problems?

What is the role of forest entomology and the WFIWC in helping to solve soceity's more pressing environmental problems?

I attended my first conference in 1957 and since then have enjoyed a long and productive association with my colleagues in the stimulating atmosphere created at these meetings. Your thoughtful attention to this important task is vital to this self-analysis. If you cannot attend the conference, please communicate your ideas, feelings, and suggestions to me or to a colleague who will be in Edmonton.

At the annual meeting, three concurrent groups discussed Chairman Wood's letter. Each workshop was led by a respective moderator. Some members unable to attend the meeting sent their comments to Chairman Wood and they are inserted after the summaries of the group leaders.

Group I - E. D. A. Dyer

This workshop was attended by 15 members. Part of a letter from John A. Chapman was read to the group. General discussion was ended by completion of a questionnaire on conference organization. The following main recommendations were made:

1. We have been and will be useful as a work conference to exchange ideas. We must maintain the informal work conference ideal without allowing the conference to promote any special interest groups.

2. We cannot exist in a vacuum however, and should seek new ideas, outside opinions, new specialities and more integrated programs. Times are changing, problems are changing, and a joint meeting with forest pathologists should be arranged.

3. Workshops need more guidelines with more ideas and less data being presented. They should be arranged around a panel theme and the panel specialists should lead the workshops also. We need more workshops and each should have a clear mission.

4. We can meet our new future requirements in our present form.

The questionnaire received strongly positive replies to the following:

1. Meeting locations should be in all parts of the west with the majority held in the more central locations.

2. Frequency of meetings should be annual as at present.

3. The meeting format should be preserved with free informal exchange of information without formal papers.

4. The program organization should include more workshops and less panels. The number of workshops held concurrently should be four or more.

5. The program length should be 3-1/2 days or less.

6. The meeting size is about right now but we could consider joining the Pathology Work Conference once for a joint meeting.

Group II - R. W. Stark - Summary Not Submitted

Group III - R. I. Washburn

The workshop was attended by 19 members all of which participated in the discussion. Bill Wilford set the stage with a brief summary of the history of the Work Conference. He stated the conference was formed because of the recognized need for forest entomologists to get together to exchange ideas, thoughts, and concepts. Informality was stressed and free open discussion was encouraged. He further stated that in his opinion the Work Conference was still strong and vibrant because the basic format had not changed except to accommodate larger attendance.

In the discussion that followed the pros and cons of the present organization and programs were argued. A large majority favored continuation of the WFIWC as now structured. The following is a sampling of comments. "The high point of the meeting to a newcomer is people." "The idea of workshops is great, smallness of groups, most are people oriented, and the informal atmosphere encourages participation." "The WFIWC proves you can have structure and still be informal." "The least valuable sections are those packed with data." "There is need to stress discussion of concepts rather than presentation of data." "There is real value in the opportunity afforded for 'gossip' interchange. We must know each other if our combined efforts are to be maximized." "This is the only meeting where forest entomologists can get together and talk bugs." "We must continue to involve other disciplines where appropriate into the work conference program."

The proposition of having joint meetings with the pathology work conference was thoroughly aired. Stu Whitney admirably represented the pathologists. Most participants favored the idea, but many cautioned against the formation of a joint work conference group.

In conclusion the members agreed upon three positive suggestions for the consideration of the WFIWC.

1. Propose the WFIWC go on record as favoring one future program devoted to a joint session with WIFDWC. The WFIWC cooperate to the fullest extent in scheduling a mutually agreeable time and place for said meeting.

2. Early selection of the theme for the annual meetings is desirable. Membership should be notified at least 90 days in advance of the theme and general nature of the program. We need to advertise the meeting program to gain support and provide opportunity for maximum attendance. We need to encourage more participation and involvement for people of other disciplines into our programs.

3. Workshop leaders need to be selected more for their ability to stimulate group participation than on technical knowledge of the subject.

4. Consideration should be given to extending the time allotted for some workshops, i.e., not all workshop topics can be covered in 2 hours.

Comments by R. A. Fisher

"I have always felt that the way the conference is conducted each year is far superior to the ordinary type of meeting. I hope that you will be able to continue it in the same format."

Comments by John Chapman

"The WFIWC has, since its inception, been intended as a work conference, and has been successful as a work conference, in contrast to a scientific meeting. I don't believe its work discussion character could be maintained if it were combined with a larger scientific meeting.

I believe the work conference has a usefulness for the foreseeable future in roughly its present form. Perhaps a valid criticism is that in this day of integrated programs and multidisciplinary approaches it is too restricted in its scope. However, the variety of backgrounds, interests and responsibilities among present members assures that broad aspects of forestry and resource management are represented and that the conference doesn't take too narrow a view.

However, in my experience some of the most thought-provoking and informative contributions at past conferences have been from invited experts outside the specific field of forest entomology but close enough to bring relevant perspectives and viewpoints to our attention. I suggest that, as has been planned for the Edmonton meeting and has taken place several times in the past, our program organizers deliberately stress outside and general fields for some invited speakers and observers. I understand the Forest Pathology Work Conference appoints someone to receive suggestions and criticisms and to present these at the end of a conference. I think we would benefit by having an experienced scientific or management observer outside our field sit in on our conferences and give an analysis and impressions at the end. I like the idea of an occasional joint meeting with the Forest Pathology Work Conference, with a program designed around common interests.

In my opinion we are, and should remain, a work conference--where informal down-to-earth discussion and exchanges of views covering all aspects of forest entomology can be carried out. We are not, nor should we try to be, a body attempting to influence opinion directly--either re: land management decisions, or forestry course curriculum, or "helping to solve society's most pressing environmental problems." We exist as a work conference and many positive results flow indirectly from the conference. We can do best to remain basically a conference

where exchanges of information may readily take place at a working level to the advantage of our sponsoring organizations."

Comments by H. A. Richmond

"In reply to your letter of February 3, 1972, regarding the future of the WFIWC, I would like, first, to review something of its history and to comment on it as an instrument for the advancement of forest entomology in the west, as envisioned at its inception.

On Thursday, October 13, 1949, this work conference was founded. An organizational committee, consisting of Bob Furniss, Portland, Jim Evenden, Idaho; and H. Richmond, B.C., was selected to prepare a constitution and by-laws for consideration at a proposed meeting in December.

This December meeting occurred in conjunction with Western Forestry on Friday, December 9, 1949. Here the name "Western Forest Insect Work Conference" was approved and the first executive elected, comprising: H. A. Richmond, Chairman; Phil Johnson, Secretary; George Hopping, Les Orr, Noel Wygant, Bill Wilford and Alex Jaennicke.

The first full-fledged conference was held in Colorado in 1950, commencing the evening of December 15, terminating Sunday evening December 17.

During the formative years, the predominate question, as one might expect--and it is again being asked--was the definition of a "work conference" and under what terms of reference should it function.

The organization changes too, always to become bigger, and more important, because this seems to be human nature.

It is not long before the organization assumes greater importance than its purpose and the ideal that gave it birth becomes servant to the organization.

If you doubt my word, consider for a moment your church, service or fraternal order, or even a work conference.

Do you know of any organization that disbanded because its objective was achieved? Long before that occurs its objective has been either forgotten or changed or, more likely, new objectives have been devised that will promote a bigger organization and its very essential annual meeting.

Without critical thoughts of the very thorough and interesting past meetings, I can't help but feel the Western Forest Insect Work Conference has gone the way of all organizations to a large degree. Your question of where do we go from here is very timely.

I have two suggestions:

1. Go back to its original objective and in the light of experience re-design it as a true work conference.
2. Eliminate it.

If the latter is done a committee should be struck to study the need of a formal technical society of western forest entomologists.

I still feel the value of a true work conference is as great as in 1949. Maybe we need a Society of Western Forest Entomologists. Maybe we need both.

In any case it's worth thinking about."

Comments by Don Schmiege

"The questions you raise in your February 3 memo to members of the WFIWC are very pertinent. I would like to present my thoughts since I won't be able to attend the Edmonton meeting because of a prior committment.

For the most part, I think we have been talking to ourselves and reinforcing the convictions of the already convinced. We have not been reaching the resource managers and also have not reached those responsible for setting research priorities. This hasn't been our fault entirely but that is irrelevant.

One possible solution is to invite well-known controversial people to our sessions which will generate interest and publicity. An example would be someone like Mike Frome. If you are familiar with what happened to him in the AFA (American Forestry Association) you will understand what I mean. Someone like Frome could present his views and we could interact by presenting our ideas on what resource managers should be doing in the field of forest protection.

The pesticides controversy is a good case in point. Nearly every week I see recommendations made by land managers concerning pesticides and for the most part they are based on little or no knowledge. In many cases they don't even know enough about it to ask the right questions. We need to turn this around. If we wait until the roof falls in from an enraged (and uninformed) public we will have failed in our obligation as expert advisers.

Meetings such as the Western Forestry and Conservation Association could provide a good platform except that they break up into subject fields such as: silviculture, fire, entomology, etc. and there we are talking to ourselves again. I have seen this happen every year. We need to reach the managers; and on the National Forests there are the rangers, supervisors, and regional foresters and staff. Their counterparts in private industry and States are usually not present

at our gatherings either, perhaps controversial news coverage will shake them loose.

I have been in the N.E. Work Conference, the Southern Conference, and the Central International Conference and I personally think the Western is the best. I think it could be improved though. One way, in my opinion is to get the attention of the people that are going to be making the on-the-ground decisions and educate them."

Comments by W. F. McCambridge

"1. Somewhat insulated from the mainstream of forest resource management.
2. Tend to emphasize the same ground each year.
3. Have not been successful in presenting a broader, more integrated view of forest protection but we are beginning to.
4. We don't influence land management decisionmaking.
5. Should try to have workshops or panels on closely associated problems such as disease, fire, silviculture.
6. Try to reach a consensus on optimum number of workshops so that we are not covering the same ground each year.
7. Should try as a group to formulate and endorse statements of policy and/or objectives for study on problems. Example--statements on consequences of no chemical control in wilderness areas."

WORKSHOP: CONE AND SEED INSECTS

Moderator: T. W. Koerber

Cone and seed insect research has fallen on hard times especially in the West. Al Hedlin's program at Victoria, B.C. has been phased out. The Weyerhaeuser program at Centralia, Washington has not been continued since Norm Johnson left. The U.S. Forest Service seed production area program in California has been abandoned and the insect research program, which depended on the seed production program for support, is presently inactive. Jack Schenk's research program in Idaho is still active at a level of effort involving one or two graduate students working mainly on insects affecting Douglas-fir seed production.

In the East, Lester Gibson's project on insects affecting seed production of hardwood trees has been terminated. The studies of insects affecting seed production of southern pines at Athens, Georgia and Olustee, Florida are continuing with reduced funding. These projects by Ed Merkle, Gary DeBarr, and Bernard Ebel are currently concentrating on the various species of *Dioryctria* attacking the cones of slash, longleaf, shortleaf, and loblolly pines.

Gary DeBarr has also been studying the effect of a seed bug, Leptoglossus coerculus on seed yields of shortleaf and loblolly pines. He has found that cones protected from Leptoglossus produced over twice as much sound seed as cones exposed to natural bug populations.

WORKSHOP: DEGREE-DAYS IN RELATION TO INSECT DEVELOPMENT AND ABUNDANCE

Moderator: W. G. H. Ives

Les Safranyik discussed some work that he has undertaken to evaluate the accuracy and precision of the sine function in estimating the degree-days above a certain threshold, using the daily maximum and minimum air temperatures. This work also attempted to determine if a bias existed, and, if so, to find methods for reducing or eliminating it.

It was pointed out that there are limits to the value of heat units: (1) they are only one of many environmental parameters; and (2) it assumed that response is linear and constant over entire period and that biologically meaningful thresholds are available for the organism under consideration.

Slides were presented, showing the location of a number of weather stations used in the study, and the calculated and planimetered (actual) degree-days during the winter and summer at each of the stations. There was evidence that a slight bias existed in some locations, especially when the threshold was higher than the minimum, but the bias was not considered serious for most purposes. Methods for improving upon the accuracy of the sine curve estimate are available, but for most applications it is doubtful whether their use is necessary because of the limitations in the value of heat units previously referred to.

Bill Ives then discussed some work he had undertaken on degree-days in relation to forest tent caterpillar infestations in central and western Canada. His presentation follows:

"The forest tent caterpillar is a native insect that overwinters as fully developed larvae within the eggs, which are laid on small twigs in July and hatch the following May. The insect is therefore exposed to the adverse effect of weather throughout its life cycle. Hodson (1941)[1/] studied the ecology of the forest tent caterpillar in Minnesota and found that embryonic development was completed in about three weeks. He later showed that this was followed by a period

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1/ Hodson, A. C. 1941. Tech. Bull. 148, Univ. Minn., Agric. Exper. Stat. 55 pp.

of obligatory diapause lasting about three months.[2/] Further development in the fall is normally prevented by the advent of cool weather. Occasionally, however, unusually warm weather occurs in the late fall, winter, or early spring, and this has been observed to cause premature hatch, or increased mortality when normal hatching finally occurs.

While working over some old forest tent caterpillar data, Ives became interested in determining if there were any detectable relationships between overwintering temperatures and the occurrences of forest tent caterpillar infestations. After considerable trial and error it was decided to use the degree days above 40°F, calculated by the modified Lindsay-Newman formulae:

$$\text{Degree days} = \frac{(\text{Max.} + \text{Min.})}{2} - \text{Thres.}, \ \text{Min.} \geq \text{Thres.};$$

$$= \frac{(\text{Max.} - \text{Thres.})^2}{2\ (\text{Max.} - \text{Min.})}, \ \text{Max.} > \text{Thres.}, \ \text{Min.} \leq \text{Thres.};$$

$$= 0, \ \text{Max.} \leq \text{Thres.}$$

These formulae are only an approximation of the true degree-days accumulation, but they are close to the formulae given by the sine curve and can be manipulated more easily, especially on a small desk top computer. Since any calculation based on daily maximum and minimum air temperatures is an approximation at best, it was felt that the Lindsey-Newman formulae met requirements. After additional trial and error, an overwintering period extending from October 13 to the following April 26 was decided upon.

Finding an useful expression for the spring feeding period was more difficult. Numerous reports can be found in the literature, attributing population crashes to adverse spring weather, but there seemed to be little consistency between temperatures and reported collapses. The number of degree-days above 60°F during the three week period followed an estimated hatch date were finally used. The latter was found to be approximated by the date on which the degree days above 40°F, starting on April 27, equalled or exceeded 110. The estimated date was purposely made conservative, and to be even more conservative, accumulation of the degree-days above 60°F did not begin until the third day after the estimated hatch date.

The hatch date was based on observations in Alberta, so it may not be too reliable in eastern Canada. However, dates given by Hodson agree quite well, so the error probably isn't too serious. In addition, since the estimated hatch date will be late, if anything, errors will tend to minimize the effects of spring weather, because the younger larvae are the most susceptible to unfavorable weather.

2/ Hodson, A. C. and C. J. Heinman. Tech. Bull. 170, Univ. Minn. Agric. Exper. Stat. 31 pp.

Published maps of forest tent caterpillar infestations were examined and a number of weather reporting stations selected in areas where there had been a fairly well documented infestation. For each of these stations the overwintering degree-days above 40°F, the estimated hatch date and the spring degree-days above 60°F were calculated during years with increasing and decreasing populations. The criteria for selecting these stations were simple: the station had to be in the area of infestation; there had to be temperature records for the period concerned; and the years of increase and decrease had to be fairly well defined. These excluded a number of areas, either because there were no meteorological stations, or the periods of build-up and decline were ill defined. The stations selected represent a reasonable cross section of the known forest tent caterpillar outbreaks in central and western Canada.

If overwintering and spring degree days are not related to population trends, the plotting of these values for increasing versus decreasing populations should give a random scattering of points. However, there is a definite grouping of points for overwintering and spring degree days, thus indicating relationships in both cases. Periods of increasing populations have significantly cooler winters and warmer springs than periods of decreasing populations.

The overwintering and spring degree-days were calculated for a number of consecutive years at each of six stations. The graphs of these values show wide variation from year to year. At first glance there seems to be little relationship between these values and periods of tent caterpillar infestation. However, closer examination reveals that all of the outbreaks were preceded by relatively cool winters and warm springs 2 - 4 years before the first recorded defoliation. In addition, some, but not all, of the populatiin collapses were accompanied by cool springs and sometimes by warm winters. However, the effects of temperature seem to be related to the stage at which they occur in the outbreak. Favorable weather seems to trigger population build-up, but unfavorable weather, unless extreme, does not appear to be able to terminate an outbreak in the initial stages. As the infestation becomes older, the effects of disease and starvation become more pronounced, and the additional stress imposed by adverse weather then seems to become important."

The two presentations were followed by a discussion of some of the problems encountered in the use of day-degrees. It was pointed out that one or both of the two conditions had to be met: (1) a considerable amount of biological data had to be available from the laboratory concerning developmental thresholds and rates of development at various temperatures above these thresholds; or (2) a large body of field data on degree-days and biological events, such as adult emergence, had to be available for a variety of weather conditions. If the first conditions could be met, it would be possible to estimate the heat units required for a given degree of development. These figures could then be used to estimate timing

of the phenomena in the field, with a minimum of field data. If the second condition was met, it might be possible, by trial and error, to estimate the developmental threshold and heat units required by selecting the threshold value that gave the most consistent relationship. Preferably, both conditions should be met, otherwise the selected thresholds might have no biological meaning.

During the discussion it was pointed out that a relatively simple phenomenon, such as peak flight for a given species, was really all that could be hoped for. Under some circumstances this might be better achieved by relating the event to some phenological occurrence, such as the flowering of some plant, than by direct day-degree accumulations. The phenological occurrence is itself a reflection of heat-units received, and may be a more reliable indicator if the micro-environment is similar.

WORKSHOP: PRIMARY ATTRACTION AND HOST SELECTION BY FOREST INSECTS

Moderator: K. Graham

The mechanisms by which bark beetles establish themselves with unequal probabilities among trees of different species, age class, vigor class and region of the stem, was strongly debated. The rousing debate highlighted a polarization of viewpoints. If it proved nothing else, it showed that we tend to judge the world through the peculiar window of our own experience.

Two contending hypotheses were taken. One hypothesis proposed that bark beetles discover suitable host trees by steering their flight toward sources of diagnostic odors (primary attractants) of suitable trees. The other hypothesis proposed that initial landing and pioneer attacks are haphazard tests which discover suitable brood trees by trial and error. Thereafter, secondary attractants (pheromones), liberated by the pioneers guide other individuals in for a massive attack.

The question was debated on two principal grounds; namely, scientific philosophy, and observational evidence, respectively.

A. Scientific Philosophical Considerations

1. The philosophical weapon known as "Occam's razor" was brandished momentarily. The implication was that the postulation of a mechanism which assumes odor guided selection of trees by directional responses of the beetles to diagnostic primary attractants (specific and condition induced) is unduly complex. This view is to be challenged on the basis of principles of plant biochemistry. Remember how the discovery of a special mechanism (mycangia) for fungal transmission by bark beetles was delayed for over a century

because postulation of a special mechanism seemed superflous.

2. Another philosophical assertion was that the proof of a hypothesis should be sought by setting up a null hypothesis. If this is valid, then the advocates of this view, who deny primary attractancy, seem not to have applied this philosophy to prove that their concept of random attack is not the mechanism which produces differential attacks. Rigid adherence to the null hypothesis would seem to obscure the profitability of experimentation deriving from conceptual synthesis and speculation about conceivable mechanisms which adhere to well-founded principles of biochemistry, tree physiology and insect behavior.

3. A third philosophical reasoning was that organisms (Scolytids), equipped (with olfactory sensors) for a particular kind of function (olfactory guidance), which operates in tracking down one class of odors (pheromones), might be expected to be capable of tracking down other cues (primary odors of host trees).

4. A fourth philosophical viewpoint sought, in effect, to evaluate the question in terms of "survival strategy" for an insect species. Investigators of western pine beetle reasoned that so abundant an insect can afford to be prodigal in squandering lives as a "trade-off" for testing all trees for opportunity. If this be valid during outbreaks, would it not be a hazardous strategy at low endemic population levels? Investigators of ambrosia beetles, reasoned that, for these insects, suitable host material is ordinarily so scarce in a forest that survival strategy would favor the use of olfactory cues for host discovery.

Strong assertions, made for specific observations, were sometimes attacked as though they had been made as generalizations. The defenders, losing some caution, fell into the trap of trying to defend an over-extended hypothesis which they did not initially intend, and of making counter attacks on a sweeping front.

B. Evidence and Rationale for and Against the Operation of Primary Attractancy

1. For Primary Attractancy

(a) Field evidence for upwind flight of a number of species of bark beetles and ambrosia beetles to logs or traps.

(b) Laboratory evidence for arrestance, anemo-olfaction, and klinokinesis in several species in response to host-derived odor. Counter argument was assertion that in the

lab the beetles may react to non-host substances, and thus response proves nothing.
(c) In the field, D.-fir beetle finds felled host tree within a few hours after felling. Thus response to odor overrides response to visual images.
(d) Whitney presented experimental field evidence based on slowing of translocation by artificial cooling of tree stem.
(e) Several alternative hypotheses based on biochemical concepts and some experiments, still in progress, indicate plausibility of primary attractancy by suggesting mechanisms by which attractancy for certain of the bark beetles and ambrosia beetles could reasonably originate or be unmasked by changes accompanying maturity and stress.

2. Against Primary Attractancy
(a) Western pine beetle often lands on "wrong" objects. (Some of this might be a result of arrestance caused by odor, and/or a result of many of the "resistant" trees emitting an odor usually associated with susceptible trees, or the "wrong landers" may be stupid clods sitting around waiting for the smarter pioneers to find suitable hosts).
(b) Western pine beetle makes mass attack only on these trees identified by successful pioneers. (This statement implies that all members of a beetle population are potential pioneers which test every tree, whereas only a small proportion might be pioneer phenotypes which select their target, while the others sit around and cheer them on).
(c) Felled ponderosa pines are poor as trap logs, compared with standing trees. This is perhaps the most convincing argument for questioning the operation of primary attractancy in the western pine beetle/ponderosa pine combination. It is thus conceivable that visual cues for vertical objects dominate the landing behavior of pioneering western pine beetles, at least until pheromones are being released. An alternative explanation might be that ponderosa pine loses attractancy quickly when felled.
(d) The ethanol which produces positive responses in *Trypodendron* and *Gnathotrichus* in "attractive" wood, may not necessarily "attract" *D. brevicomis.* Ethanol does not "attract" *D. ponderosae,* but causes other responses.
(e) Principal dependence of *D.b.* on an aggregative mechanism (pheromones) may be advantageous for an insect which as individuals, cannot overcome resinous impediments. Such aggregation is not so important for an ambrosia beetle, or even D.-fir beetle, even though pheromones do play an aggregating role.

When the smoke cleared, it appeared that the positions taken by the participants in the debate had not changed substantially. It seems likely that different species of beetles employ the different mechanisms in their survival strategy. More clarification of the question is needed.

PANEL: COST-BENEFIT ANALYSIS OF RESEARCH

Moderator: J. Smyth

Panelists: J. E. Marshall, T. Tucker, R. B. Forster

Benefit - Cost Analysis of Research: J. Smythe

From time to time all of us must make decisions concerning problems that affect our personal lives. Some of these problems may require considerably more thought, or input, than others to arrive at a satisfactory solution. We may, for example, be faced with a problem of deciding among a number of opportunities where to invest our money; stocks, bonds, term deposits, mutual funds, etc., or we may be faced with the simple problem of deciding which movie, among several, to attend. When we finally make a decision as to what to do, it will be, undoubtedly, to maximize the return from the investment--whether it be in the form of dollars or satisfaction. In the first case we would probably seek the advice of an investment specialist; in the second, we may simply toss a coin, draw straws, or rely on conjecture. In both instances, however, we have relied on some type of assistance to guide our thoughts in deciding the more appropriate course of action to take.

This same principle of investing funds is equally applicable to our research programs. The objective is to maximize the return on the investment or research dollar or, to put it in other words, maximize benefits relative to costs. This objective is particularly important in government research where it is the taxpayer who is footing the bill. The taxpayer should expect a reasonable or fair return on his tax dollar. Assuming we agree on this particular point, many of you are probably asking yourselves how can one evaluate a research project in order to estimate the net benefits that will be derived from the costs incurred, particularly, when the majority of benefits will not accrue until there has been some expenditure?

One of the more common analytical tools which can help us with this problem of evaluating research projects, and the one which we are going to hear something about this morning, is benefit-cost analysis. Briefly, this economic tool provides us with a comprehensive method whereby the right questions may be asked and answers produced in such a way as to provide the means for more intelligent decision-making in the allocation of scarce resources.

Without any further comments about this subject I would like to introduce our guest panelists...

Mr. Jim Marshall, economist, Forest Economics Research Institute, Ottawa.

Mr. Tom Tucker, economist, Great Lakes Forest Research Centre, Sault Ste. Marie

Mr. Robert Forster, economist, Forest Economics Research Institute, Ottawa.

Cost-Benefit Analysis of Research: J. E. Marshall

Cost-benefit analysis has for some time now played an influential role in the decision-making processes of business, government, the military and science. Currently it is one of the more specific tools of systems analysis, and its use by government agencies has been stimulated by the present emphasis being placed on Planning Programming Budgeting (PPB).

The cost-benefit analysis method of reducing complex information respecting flows of costs and benefits expected to occur in the future, to present day value terms, permits decision-makers to make objective assessments of alternative goals and endeavours.

Cost-benefit analysis, particularly as practised by business, is often known by other names; notably, capital budgeting, and discounted cash flow analysis.

As a technique it is far from new. Indeed, Martin Faustmann used discounted cash flow analysis to determine soil expectation value in 1849. (Foresters may be familiar with his name).

Its modern day popularity, however, began in the mid-1950's and is due to the works of much more contemporary authors[1/].

Many researchers believe that cost-benefit analysis cannot be applied to their work because their work is an exploration of the unknown and the unknown cannot be planned or costed. However, as one program analyst put it, "any project form that I am familiar with requires, in some fashion, a statement about (1) what work is planned (2) the justification for such work, and (3) the duration of the project. These three items form the essential ingredients for a Benefit/Cost analysis."[2/]

Basically there are two different schools of thought respecting what criterion is appropriate for the evaluation of investments: The school that seeks to maximize net present value, and the school that seeks to maximize the internal rate of return. Cost-benefit analysis belongs to the net present value school. They draw a clear distinction between returns to the entrepreneur and returns to the owner of capital and this makes them adherents of Frank Knight's uncertainty theory of profit.[3/]

1/ See - Hirschleiffer, J."On the Theory of the Optimal Investment Decision." J. Political Economy 66: 329-352

2/ Puterbaugh, Horace, L. PPB, Research and Things Like That, presented at the Purdue Symp. on the Organization and Manage. of Agric. Economics Res., Lafayette, Indiana, March 16-17, 1970, 4 p.

3/ Knight, F. Risk, Uncertainty and Profit, Houghton Mifflin, Boston, 1921, 381 pp.

This theory holds that entrepreneurial endeavour, which is rewarded by profit (or loss), only takes place because of the uncertainty of outcome associated with enterprise.

The reasoning behind this theory is that in a certain world the outcome of enterprise would be known in advance, and the factors of production (land, labour and capital) would demand and divide among them the entire known product of enterprise.

Because of uncertainty, however, the exact worth of the future product is unknown. The entrepreneur, therefore, speculates as to the future worth of his product and determines whether he can obtain for a price contracted now, the factors of production required (land, labour and capital) and still provide himself with a margin left over (profit). Extending this explanation to corporate enterprise, the shareholders are seen to simply contract the entrepreneurial function to paid management.

Description of technique

To use an example, suppose an entrepreneur speculates as follows:

(a) His cost of capital is 10% annually and he will require an initial investment of $25,000 in land and $75,000 in plant and equipment,
(b) The productive plant and equipment in which capital is invested will have a useful life of 5 years,
(c) The annual cost of labour needed to operate the equipment is $15,000,
(d) The annual cost of power, fuel, materials, maintenance and repair is $15,000,
(e) The annual revenue realized from sale of the product produced will be $60,000.

His expected cash flow picture is as follows.

Present worth	Years 0	1	2	...	5	Monetary Flow
- 9,477	-25,000	0	0	...	+25,000	Land acquisition and sale
- 75,000	-75,000	0	0	...	0	Capital expenditure
- 56,862		-15,000	-15,000	...	-15,000	Labour expenditure
- 56,862		-15,000	-15,000	...	-15,000	Fuel & material cost
+ 227,447		+60,000	+60,000	...	+60,000	Sales revenue

+ 29,246 = net present value

If the $75,000 capital expenditure in plant and equipment in year 0 is expressed instead as a self-liquidating 5 year loan at 10% interest, the equivalent annual charge (principal plus interest) is $19,785, and if the economic rent equal to 10% of the $25,000 non-depreciating investment in land is shown as an annual charge, the expected cash flow picture becomes:

Present worth	Years 0	1	2	....	5	Monetary flow
- 9,477		- 2,500	- 2,500	....	- 2,500	Land rent
- 75,000		- 19,785	- 19,785	....	- 19,785	Capital expentiture
- 56,862		- 15,000	- 15,000	....	- 15,000	Labour expenditure
- 56,862		- 15,000	- 15,000	....	- 15,000	Fuel & material cost
+ 227,447		+ 60,000	+ 60,000	....	+ 60,000	Sales revenue
+ 29,246		+ 7,715	+ 7,715	....	+ 7,715	Profit

This enterprise has an indicated positive net present value of $29,246 and a benefit/cost ratio = 227,447/198,201 = 1.15. If a profit maximizing objective is to be pursued, investment would be warranted barring no constraints.

A government agency, however, with the exception of a Crown corporation, probably will wish to stimulate private enterprise without deliberately influencing how the product of such enterprise is divided among the factors of production and the entrepreneur. Likely it will desire only to encourage the maximization of the net value of production or value added by the enterprise to the Gross Domestic Product (G.D.P.).

The annual value added in the cash flow picture shown is $45,000. It equals the annual sales revenue ($60,000) less the annual cost of power, fuel, raw materials, maintenance and repair ($15,000 which is value added by other enterprise). It also equals the annual land rent plus the annual capital expenditure plus labour expenditure plus entrepreneurial profit.

i.e. value added =

			land rent	$ 2,500
			plus capital expenditure	19,785
sales revenue	$60,000	or	plus labour expenditure	15,000
less cost of fuel			plus	7,715
and materials	-15,000			
	$45,000			$45,000

Value added, therefore, is formally defined as being the value of shipments of goods of own manufacture less the costs of fuel and electricity, and materials and supplies used. It expresses the combined returns to land, capital, labour and entrepreneurial endeavor realized by the production and sale of a product.

Anticipated value added, therefore, is a flow just like expected entrepreneurial profit is a flow, and its net present value can be computed by discounting in precisely the same way as is the net present value of an expected profit flow, or any other flow for that matter.

The sum of all value added in the country in a year equals the G.D.P. for that year. The G.D.P. adjusted for subsidies and transfer payments equals the G.N.P.

When conducting a cost-benefit analysis of R. & D. proposals, opportunity costs should be subtracted, where appropriate.

An opportunity cost is the value foregone in allocating productive resources to a chosen endeavour rather than to an alternative. Therefore, if a mutually exclusive alternative exists for which the net present value is independent of any contribution being claimed as value added by the proposed endeavour, it is appropriate that the net present value of the alternative be subtracted from that of the proposed in order to determine the net addition to G.D.P.

For example, if R. & D. results in a less costly method for developing a product, a mutually exclusive alternative to the new method, and one in which the R. & D. has played no contributary role, is simply to continue production by the old method. The net addition to the G.D.P. by the new method, then, is only the difference between the value added by it and that added by it and that added by the old.

Decision rules respecting cost-benefit analysis

After the present worths of anticipated cost and benefit flows have been determined for proposed endeavours, two decision rules respecting acceptability can be applied: The first requires that the net present value of an endeavour be positive or, if one prefers, that its benefit-cost ratio be greater than one. Unless this condition is met, the costs of land, labour and capital cannot be expected to be totally recovered and a loss must be anticipated.

The second rule suggests that where the number of endeavours that can be undertaken is limited, total net present value or wealth will be maximized if endeavours are chosen in order of highest benefit-cost ratios first. Unfortunately, if the proposed endeavours are of widely differing size, blind adherence to this rule may not maximize total net present value.

<u>Type of data required</u>

The types of expected cost and benefit flows discussed up to this point have been monetary in form. However, limiting cost-benefit analysis to the processing of quantitative economic data, to the exclusion of personal and environmental influences, may seriously distort the decision-maker's vision.

Non-economic flows, though, are most easily handled if they can be expressed in proxy-monetary terms. Where the total expected net benefit flow is entirely monetary, cash flow analysis will suffice, but where part or all of the total expected net benefit flow is non-monetary, it is quite possible that the present worth can only be expressed in proxy-monetary terms (e.g. an asset such as a library, a park, or clean air would fall in this category). Even where the present worth of non-monetary flows can be measured by market analysis, (e.g. the market value of a rare stamp, a painting, or a cottage lot) there is no guarantee that this measure includes the present worth of all non-monetary benefit flows. That is to say, some non-monetary benefit flows that should be recognized may not be valued by the existing market.

It is also possible that a contrary situation can occur where the present worth appraised in proxy-monetary terms proves to be less than the present worth indicated by sales analysis. Here, the proxy-monetary appraisal may have missed some non-market benefit flows, different quantities of flows may have been anticipated, or the same flows may have been anticipated but they may have been evaluated differently.

While sales analysis can be of great value in aiding and verifying benefit flow analysis, care must be taken to ascertain exactly which benefit flows are represented and which, if any, are not. For instance, sales analysis may show that a woodlot sold recently for $50,000. Cash flow analysis may show that the annual net value of wood produced has an indicated present worth of only $25,000, but further investigation may reveal that the property also has excellent recreational and aesthetic attributes worth an additional $25,000 to the purchaser.

Recently a behavioural approach to cost-benefit analysis has been put forward by Leo Spier of Pennsylvania State University[4/].

Spier maintains that divergent personal and environmental conditions within and across cultures alter the behavioural context that surrounds the decision-making process and that they are crucial to the effective resolution of problems.

4/ Spier, Leo, "A Suggested Behavioral Approach to Cost-Benefit Analysis," Management Science, Vol. 17, No. 10, June 1971, pp. B-672-B-693

He makes the following assumptions:

(1) The central objective for man is satisfaction of needs underlying self-maintenance and self-perpetuation;
(2) As a psychological consequence of these universal needs, man's internal drives provide him with a capacity for positive-negative evaluation of the objective;
(3) In his drive to satisfy needs, man must rely on environmental resources, whose specific qualities generate distinct patterns of action and thereby provide for a theoretical classification of universal need;
(4) Based on his perception of the internal and external situation, man formulates specific norms and values for an appropriate course of action to satisfy his needs from the specific resource qualities;
(5) The perceived nature of need (internal factor) determines the content of a value and therefore the type of behavioral response; and
(6) The perceived qualities of the resources (external factor) determine the relative impact of a value and consequently the spatial and temporal variations for a typical behavioral response.[5/]

It is further contended that man in society is a mix of three basic personalities; the proportionate mix depending upon prevailing need-resource conditions. These personalities reflect self-directed, other directed and symbol directed attitudes and may be seen in economic, social and ideological behaviour. Man's economic behaviour is characterized by exploitation of the forces of nature and is a response to physical needs. His social behaviour is characterized by compliance with the artificial environment and is a response to emotional needs. His ideological behaviour is characterized by reasoning about his environment a political, religious, or scientific doctrine and is a response to his intellectual needs.

Spier provides us with these examples: "...man in his role as business executive, satisfying physical needs, is committed to himself; he views his fellow men as a material resource quality and interacts with them on the basis of competition. The same man in his role as father, satisfying emotional needs, is committed to others; he now views the same fellow men as an empathic resource quality and interacts with them on the basis of cooperation. The same man in his role as scientist, satisfying intellectual needs, is committed to principle; he now views the same fellow men as an incorporeal resource quality and interacts with them on the basis of personification[6/]."

This economic, social, ideological composite of total value enables one to see the shortcomings of including only economic data in the cost-benefit analysis of a problem--the quantifiable part, in fact, may not be very relevant to the analysis of the problem.

5/ Ibid., p. B-674.
6/ Ibid., p. B-682.

Spier argues quite convincingly, for example, that the reason the cost-benefit analysis developed by the U.S. Defense Department to measure U.S. military effectiveness in the Vietnam war failed, was because it placed U.S. value weights on the evaluation criteria used rather than Vietnamese value weights.

Materialism has long been the predominant value standard used in the North American environment, and this may mean that past disregard of non-economic values in cost-benefit analyses of domestic problems has not been too serious. Nevertheless, the psychologists tell us that changes in the resource structure usually precede changes in values manifested by differing personalities, and when the perceived impact of a changing resource quality has sufficiently impaired man's traditional means for need-satisfaction, a change in values will ensue.7/

Pollution has already impaired some of North American man's traditional means for need satisfaction and quite a change in values has recently occurred. Economic benefits obtained in the past were frequently accompanied by social and ideological costs that were not recognized. With the recent shift in value weights, social and ideological costs can easily assume a magnitude that outweights anticipated economic benefits.

The potential that cost-benefit analysis has for evaluating the intricate issues that confront our institutions, whether they be private or public, depends entirely on our ability to quantify in relatable terms data that accurately reveal expected flows of social and ideological values as well as economic values.

Cost-benefit analysis remains a quantitative technique designed to easily and meaningfully evaluate quantitative flow data. If such data are available, they can be used as easily to evaluate a biological research program as they can to evaluate a business investment program.

7/ Ibid., p. B-681

Can Intangible Benefits be Quantified? T. L. Tucker

Jim Marshall pointed out to us that nonmarket benefits do influence the decision maker and are not adequately represented in a net present worth figure. He also indicated that economic criteria and human values are both extremely important in determining the relevant benefits and costs. I would like to start here and expand a little on the basic information needed in order to evaluate intangible as well as tangible outcomes.

In any research project or for that matter, any management or policy undertaking, a number of inputs are required and a number of outputs generated. To evaluate the worth of undertakings, some standard is needed to measure the benefits against. These standards, normally called objectives, goals or mission, are the base decision makers use in order to determine the worth of undertakings.

The first order of business in any evaluation is to obtain a clear statement of goals or objectives from the policy maker (Davis, L. S. and W. Bentley, 1967; Fedkiw, J., 1968; Stoddard, C. H., 1968; Vaux, H. J., 1968; Hinrichs, H. H., 1969; Province of Ontario, 1969). One of the biggest problems encountered by the economists concerned with Program, Planning and Budgeting (P.P.B.) analysis in the U.S. Forest Service was just this problem of obtaining a clear statement of objectives from administrators of the Department of Agriculture and Forest Service.

If objectives are not clearly stated, they will be assumed by researchers, administrators and politicians. The implicit objectives of these groups generally conflict as evidenced by recent arguments over environmental quality, quality of life, conservation and preservation. Bitter emotional and philosophical arguments can and do arise concerning proposed research, resource development and new policies because explicit objectives and goals are lacking.

I would like to illustrate briefly what can happen if objectives are not stated or are assumed. Recently in a midwestern university in the United States, a research project was conducted using a private grant. The goal was to find a method for controlling a particular species of fly that is an extreme nuisance to dairy cattle. The number of possible controls was limited, because of legal restrictions on permissible chemical levels found in milk; therefore, the control could not include insecticides. The solution came when the researcher noted that adult insects fed in the cow's fecal material. He hypothesized that if an abrasive material was added to the cow's feed, it would eventually end up in the excrement and the flies' feeding habit would cause the cuticle on its exoskeleton to wear off and the insect would desiccate.

Actual results gave 90 percent control with no adverse effects to the milk quality. However, the amount of inert abrasive required to obtain this control level was nearly 30 percent by volume of total food intake, thereby lowering the quantity of milk produced by a similar percentage. This imaginative piece of research was not implemented because it did not meet the objectives of the dairy farmer; which were to have a control with no decrease in milk quantity or quality. An explicit statement of such objectives would probably have led to a more tenable solution.

I realize that this example was overworked to make a point, but it is a fact that benefits from individual projects cannot be

evaluated effectively unless the objectives of the funding organization are explicitly and simply stated.

Now I would like to concentrate the discussion on the intangible benefits. Roland McKean defines intangibles as outcomes which cannot be readily translated into the common denominator that is being used (McKean, R. N., 1958). The common denominator in greatest use is the dollar and it will be used in the remainder of this discussion. Dollar benefits are market benefits--all others will be considered intangibles.

Two questions arise when considering intangibles. Which intangibles should be included and how should they be measured? It is generally agreed that those intangibles which are describable only in vague and elusive terms should count for little and in most cases should be ignored (McKean, R. N., 1958; Davis, L. S. and W. Bentley, 1967). Including such intangibles would cloud the analysis and hamper the decision maker.

General agreement is also found concerning the measurement of intangibles. No single criterion can adequately be used to evaluate both tangible and intangible benefits (Ciriacy-Wantrup, S. V., 1955; McKean, R. N., 1958; Milliman, J. W., 1962; Castle, E. N., 1965; Davis, L. S. and W. Bentley, 1967; Leven, C. L., 1970). The above assumes that profit maximization is not the only objective. If it were, then by definition intangibles are unimportant as far as the decision maker is concerned. In this case an economic efficiency criteria can adequately measure market performance (profit maximization). However, if social or non-market objectives are part of the decision maker's package of goals, then no single criterion will adequately measure all the benefits.

Conceptually, the benefits could be put into several benefit evaluation accounts; one for each major objective. All market benefits would go into an economic efficiency account and the remaining intangible benefits into the appropriate account representing the remaining objectives. One such system was suggested by a special task force of the U.S. Water Resource Council (U.S. Water Resource Council, 1969). Four separate accounts were presented:

(1) Economic efficiency account
(2) Well-being account
(3) Regional account
(4) Environmental quality account

Presumably, these four accounts represent the major objectives of the Council. The number and the names of the accounts would vary with the objectives of the organization. As a matter of fact, within any organization objectives would change over time as mission changes and as observed needs change. Environmental quality is a recent case in point. The important thing is the explicit specifications of the objectives which determine the benefits which will be evaluated and used in the decision making process.

I have talked generally about the importance of objectives and the importance of excluding vague or ambiguous intangible outcomes. Now I would like to discuss the problem of quantifying intangibles.

By quantifying intangible benefits, they are really made tangible and concrete to the decision maker. Quantification need not be in dollars. Any suitable measure can be used to quantify intangible and they need not be measured perfectly. I would like to discuss briefly two methods of quantifying intangibles; opportunity cost and relevance numbers.

Jim Marshall has just outlined the concept of opportunity cost. I would like to expand on his discussion and show the usefulness of this measure in valuation of intangibles. As a reminder, opportunity cost is defined as the cost of alternatives, foregone or sacrified, in order to receive some other output. In our case, the output is an intangible benefit.

This definition leads to two conclusions--conclusions by the way which are often overlooked when we hear discussions about wilderness areas, redwood trees, motherhood and apple pie. First, no intangible has infinite value and second, all intangibles have costs (Milliman, J. W., 1962). With this in mind, opportunity cost really defines the minimum worth or minimum value of the intangible.

A good illustration of this came up during a conversation this week about a current resource use conflict here in Alberta. I am told that Mount Rundle is in a beautiful scenic area, but also an area bearing coal deposits. Apparently the coal mining operations are destroying the scenic values by causing great scars along Mount Rundle's base and leaving large piles of rubble.

Suppose an accurate estimate of the value of the coal in Mount Rundle is $10 million. If we (politicians) decide to exclude coal mining from the mountain in favour of the scenic values, then the scenic values must be worth to us at least the value of the alternative sacrificed to get them. In this case the value of the coal ($10 million) is the alternative sacrificed and, therefore, the minimum value of the scenery.

Opportunity cost is a minimum value because it shows only what you had to give up in order to obtain something else. It does not show what you would be willing to give up in order to attain the desired outcome. In this case, if the coal had been worth $15 million, we might still favour scenic values, but if it was worth $20 million we would favour coal. Suppose $18 million was the switching point, then $18 million is the amount we would be willing to pay or the value to us of the scenery. In practice only, a $10 million sacrifice was required and that amount is the opportunity cost or minimum value of the scenery.

The question has changed from--Is the scenic value of Mount Rundle worth more than the coal deposit? to Is the scenic value of Mount Rundle worth $10 million? As you see, opportunity cost does not eliminate value judgements or political decision, but rather provides objective information on value and trade-offs, which allow for better decisions to be made. In this case, we are taking from Peter to pay Paul. Opportunity cost helps us to decide if what Paul gets is worth what Peter gives up.

This approach has been used in several studies dealing with recreation valuation (Atkinson, W. A., 1956; Rickard, W. M. et al., 1967; Manning, G. H., 1969). Also, it is found as an integral part of most economic evaluation of differing timber management and silviculture techniques.

The second method I would like to present involves subjectively putting weights on the stated objectives reflecting their relative importance to the policy maker. Then the individual projects are evaluated by a team of administrators and researchers for their percent contribution to the various objectives, i.e., 30% of projects benefits are to profit, 40% to environmental quality enhancement, etc. By multiplying these percentages by the weights of the corresponding objectives and summing them for all objective categories, we get a pure number known as a "relevance number." The technique for doing this is called "Delphi" technique. Its use is found in the literature of various organizations and professions among them the military, engineering, education and forestry (Helmer, O., 1966; Cetron, J. J. et al., 1967; Jestice, A. L., 1967; Bandrowski, S. S., 1968).

The relevance numbers once calculated can be used to rank a number of projects. Subjective weighting also has the advantage of combining tangible and intangible benefits into one pure relevance number.

Time does not permit nor was the mandate given, to detail the pros and cons of these techniques or go deeply into the actual mechanics of each method.

Where forest management, insect and disease control and in general where applied research is important, opportunity cost may be the best technique. Where basic and pure research is being done, relevance numbers may be best. Most government agencies have such a mix of projects and benefits that a combination (of market values, opportunity cost and relevance numbers) may be used[1/].

1/ Marshall, J. E. 1970. A Proposed Methodology for Planning Programming, Budgeting, for the Canadian Forestry Service, that Complies with the Treasury Board Gud. Unpublished Report. Forest Economics Research Institute, Canadian Forestry Service, Department of Fisheries and Forestry, Ottawa, Ontario. 48 pp.

I would like to close by restating the major points. First, objectives must be explicitly stated and they must be stated by policy makers. Second, no single criterion can adequately measure all outcomes. Therefore, a combination of criteria are needed, i.e., net present worth, opportunity cost and relevance numbers. Third, any intangible worth considering can be expressed by some measure, although often imperfectly.

Better decisions are made when decision makers have quantitative information on both the tangible and intangible benefits that influence their goals and objectives.

Literature Cited

Atkins, W. A. 1956. A Method for the Recreation Evaluation of Forest Land. M.S. Thesis. Department of Forestry, University of California, Berkeley, California

Bandrowski, S. S. 1968. Forest Programme Analysis, A Proposal for the Decision-Making Model. Forest Economics Research Institute. Department of Forestry and Rural Development, Ottawa, Ontario. 30 pp.

Castle, E. N. 1965. The Market Mechanism, Externalities and Land Economics. Journal of Farm Economics 47(3): 542-556

Cetron, J. J. et al. 1967. The Selection of R & D, Program Content - Survey of Quantitative Methods. IEEE Transactions on Engineering Management, 14(1). p. 6

Ciriacy-Wantrup, S. W. 1955. Benefit-Cost Analysis and Public Resource Development. Journal of Farm Economics 37(4): 676-689.

Davis, L. S. and W. Bentley. 1967. The Separation of Facts and Values in Resource Policy Analysis. Journal of Forestry 65(9): 612-620.

Fedkiw, J. 1968. Planning Forest Resource Management in U.S.D.A. Journal of Forestry 66(10): 768-773.

Helmer, O. 1966. The Use of the Delphi Technique in Problems of Educational Innovation. Rand Corporation.

Hinrichs, H. H. 1969. Government Decision Making and the Theory of Benefit-Cost Analysis: A Primer. 9-20. In Hinrichs, H. H. and Graeme M. Taylor. Program Budgeting and Benefit-Cost Analysis. Goodyear Publishing Co., Pacific Palisades, California

Jestice, A. O. 1967. Pattern Long Range Corporate Planning. Honeywell, Aerospace and Defense Group, Military and Space Sciences Department, 76 pp.

Leven, C. L. 1970. A Framework for the Evaluation of Secondary Impacts of Public Investment. American Journal of Agricultural Economics 52(5): 723-729.

Manning, G. H. 1969. Resource Allocation and Non-Market Benefits. Forest Economics Research Institute, Forestry Branch, Department of Fisheries and Forestry, Ottawa, Ontario. Information Report E-X-4, 30 pp.

McKean, R. N. 1958. Efficiency in Government through Systems Analysis. John Wiley and Sons Inc., New York 336 pp.

Milliman, J. W. 1962. Can People be Trusted with Natural Resources? Land Economics 38(3): 199-218.

Province of Ontario. 1969. Effective Management through PPBS. Treasury Board of Ontario, 68 pp.

Rickard, W. M., Jay M. Hughes, and Carl A. Newport. 1967. Economic Evaluation and Choice in Old-Growth Douglas-fir Landscape Management. U.S.D.A. Forest Service Research Paper PNW-49, Pacific Northwest Forest and Range Expt. Sta., Portland, Oregon 33 pp.

Stoddard, C. H. 1968. Some Aspects of the Political Decision in Forestry. Journal of Forestry 66(10): 782-785.

U.S. Water Resource Council. 1969. Report to the Water Resource Council by the Special Task Force: Procedures for Evaluation of Water and Related Land Resource Projects, Washington, D.C.

Vaux, H. J. 1968. Goal Setting: Meeting Ground of Management and Policy. Journal of Forestry 66(10): 799-803

Application of Cost-Benefit Analysis to Insect Research and Control Programs: R. B. Forster

Here it is, the last day, the last session and I am the last speaker, so let me be the last to welcome you to the Twenty-Third Annual Western Forest Insect Work Shop. I really don't know what I am doing here, and to make matters worse, some of you don't know what I am doing here either.

A chap I met in the hall a couple of minutes ago said, "What are you doing on the program?" The only bug problems you have ever encountered are bugs in your computer programs and you can't even identify those."

Be that as it may I want to congratulate each and every one of you for stumbling down here to join us this morning. I am not sure that after all afternoon off and last night's bash, that I would have made it, had I not been on the program. Economics can be a dull subject. I had my first economics course at 7:30 a.m. Monday, Wednesday and Friday at Michigan State and believe it or not I decided that Entomology was a lot more interesting. I spent the following summer counting bugs for Paul Flink, Michigan's entomologist. I don't know if I saw the light that summer, or stumbled back into the darkness but here I am, back in the dismal science, a numbers cruncher, talking to the bug counters about benefit/cost analyses.

The first speaker, Jim Marshall, set the stage. He defined benefit/cost analysis and described methods of carrying it out. He went beyond classical methodology and brought in subjective values. He stated that the values needed include not only economic values but social and ideological values as well. The second speaker, Tom Tucker, picked up the cue from Jim. He explained that, to be included in a benefit/cost model, these social and ideological values must be translated into economic terms. He described some of the difficulties of doing this. He also described some of the difficulties of including secondary and tertiary benefits in the analysis and if these factors are to be included, secondary and tertiary costs must also be included. For example, the benefit which can be attributed to the construction of an irrigation dam might be the rental value of the irrigated land minus the rental value of the unirrigated land. To attribute to the dam, the value of the corn which can be grown on the land is questionable and to justify the dam by the market value of the whiskey which can be made from the corn is ludicrous. So you see, the application of benefit/cost analysis is not without its difficulties. And that is the topic I am commissioned to discuss with you; the application of benefit/cost analysis to bug programs.

In fulfilling my mandate, I will cover two broad subjects:

(1) the application of benefit/cost analysis to control programs and
(2) the application of benefit/cost analysis to research programs.

I am going to discuss two studies which have come across my desk in the past three years. I will speak only in generalities because I make it a point not to volunteer criticism of a project if the responsible individual is not present to defend his position.

The first study I would like to describe is a benefit/cost analysis carried out on a control program. I chose the control program study first because it is a lot simpler than the evaluation of a research program. The spruce budworm spray program in New Brunswick began in 1952. It was relatively modest, involving a

few hundred thousand dollars. Everyone assumed that with a couple of years of spraying we would be all through. By 1965, the cost per year had risen as high as 1.7 million dollars per year. Treasury Board, said "Whoa Baby" this thing is beginning to look like a bottomless pit. Let's take a look at it and see if benefits are in line with costs. And so a cost/benefit analysis was carried out. It was a tough job because all sorts of marginally related issues clouded the main topic. Among these were regional disparity, federal-provincial relations, unemployment and the fear of an imminent timber shortage. These factors have a place in the evaluation of any forestry program but it is very difficult to include them in a traditional benefit/cost analysis. Let's take a look at the study and comment as we go along. Costs were pretty straight forward. It was assumed that 1.2 million would be spent annually for 10 years, 1960 to 1969, for a total value of 12 million dollars. With 20-20 hind sight we realize that this was a pretty healthy under estimate. This year, 3.4 million dollars will be spent on the New Brunswick spray program. It was assumed that the present consumption 300,000 cunits per year would increase to 600,000 cunits. Today's figures indicate that an increase did occur but it was not of the magnitude expected. Now the big step, the estimation of value. Value is a function of time, place and form. There are three ways to place a value on something, (1) estimate its current market value, (2) estimate the cost of producing it and (3) estimate the cost of replacing it. So the timber saved could be valued at (1) the current or expected cost of stumpage, (2) the cost of growing it or (3) the cost of buying it somewhere else and shipping it in. In New Brunswick, the cost of stumpage is nominal, the cost of producing it is nothing, and so my inclination would be to use the cost of shipping it from elsewhere. In the study, welfare, social amenities and unemployment clouded the issue and the net value of the logging industry was used as value saved.

This value of course is the value added by the logging industry. To use this value, one must assume that the individuals employed in the logging industry would not gainfully be employed elsewhere. I believe that one could easily challenge this assumption. This value is considerably greater than the value of stumpage but I am not really sure that it is that much greater than the cost of replacement, a value which could be easily defended.

The individual who carried out this study is a very able practitioner. The weakest point of any study is the assumptions. One has to start somewhere and that starting point is the set of assumptions. It is my opinion that the assumptions in this study are not realistic. Just in passing, it is very doubtful whether this problem will ever arise again at a federal level. The federal government is no longer in the spraying business. Contributions ceased in 1969 and the total cost of spraying is now carried by the provinces and industry. And so, unless we are asked, who are we to say how someone else should spend his money.

I want to mention two problems before I go on with the second example I wish to discuss today. The first problem is the disassociation of costs and benefits and the second problem is what I would call the aggregate value saved problem. The first problem deals with who pays and who gets the benefits. It is pretty hard to convince a farmer at the head of a draw to put in a $1,000 flood control dam to prevent $50,000 worth of damage down stream if all it does for him is back up water on his property. It is equally hard to get industry to support a million dollar spray program if all it does for them is preserve wood to support the construction of new competitive firms. In doing a benefit/cost study you have to decide who you represent and all costs and benefits have to be in relation to that "who."

The second problem is one that you will encounter again and again in the evaluation of insect and pest control programs. It has to do with aggregating values of resources which the programs are designed to save. Let me use an example. Suppose a farmer builds a $500 chicken coop in a river bottom which floods each year. He calls in his handy dandy soil conservation consultant who informs him that the only way to save the chicken coop is to construct a $1,500 flood control dam. It is easy to justify and he fills out the following benefit/cost analysis form.

	Savings
Year 1	500
Year 2	400
Year 3	300
Year 4	200
Year 5	100
Year 6	50
	1,550

$$\frac{\text{Benefit } 1{,}550}{\text{Cost } 1{,}500} = 1.03$$

The first year the farmer saves the full $500. In the second year the chicken coop depreciates a bit and the value has to be discounted for one year so the farmer saves only $400. And the savings continue; $300 the third year, $200 the fourth year, $100 the fifth year, at which time the coop falls down and he sells the scrap lumber for $50. Total savings is $1,550; total cost is $1,500, for a benefit/cost ratio of 1.03.

This is easy to do with trees. You save one $100 tree ten years in a row and the benefits are $1,000. The only way out of this dilemma, is to use the value of the flow of benefits which the resource provides. If the chicken coop provides the farmer with $100 worth of income per year for five years, this is the value which must be plugged in as a benefit; not the capital value of the resource. In the previous study, the Spruce Bud worm study, this cash flow value was the value used. It is fantastic how many times this principal

is violated. Look at forest fire statistics which state that millions of dollars worth of timber burn each year. Actually what is destroyed is a cash flow. People reporting the destruction resulting from insect epidemics are guilty of the same faulty reasoning.

The second study involved the winter moth which apparently chomps up red oak leaves like there is no tomorrow. From what I understand, three good, or from the tree's point of view bad, defoliations and the tree gives up the ghost. The research program consisted of the evaluation of various parasites. Six were found to be effective and were released with the result that this pest is virtually under control today. Now, after all had been said, and done, a benefit/cost analysis was attempted with the intention of showing the fantastic benefit which occurred as a result of the research program. Thus the first principal of benefit/ cost analysis was violated. Benefit cost analysis is a tool which is used "a priori" to evaluate a project, or to compare two or more alternatives. It is not a tool to apply after the fact to illustrate what a good guy you are.

In spite of this disregard for the proper technique, let's examine the model itself and evaluate the validity of the cost and benefit entries. On the cost side were total budgets expended on the research programs. We can quarrel about what should or should not be included as costs but I don't think it is important. On the benefits side was the current market value of about 40 percent of the total volume of red oak in Nova Scotia, which was estimated to be about 124 million cubic feet. Forty percent was the estimated mortality of the red oak without treatment. Also included was a considerable volume of white pine to which the red oak was a nurse over story and without which the white pine would be susceptible to white pine weevil. The white pine was also valued at the current market value. The market value of other species which would be attacked by the moth were also included. A second benefit included was the money which towns and cities would spend in the purchase and application of insecticides to protect their ornamental trees from this pest. An estimated value of the ornamental trees which would eventually succumb was also included.

I have already stated that I think the present worth of cash flow is a better method of estimating benefits from a preventive program. It is true that these benefits were valued only once but some of this resource would never have been cut and that which will be cut in the coming years has to be discounted to the present. The point here is not, how to include these benefits but whether or not these benefits should be included in the benefit/cost analysis of a research program.

There are two types of research programs. In the first type, we are right on the edge of knowledge and we are striving to discover new techniques on controls to cope with current problems. Discovering a cure for the Dutch Elm Disease is an example of what I am talking about. The second type of research program is the evaluation of

control programs which are currently technologically feasible. The benefit of the first type of program is the value of the new product or technology, minus the costs of application and minus the operating costs. I will not spend a great deal of time outlining the appropriate procedure to use in these cases because in reviewing the entomological program in Canada, I find that very few studies fall in this category. Most of the studies dealing with control, are concerned with determining the effects of applying known technology to the specific circumstance. This, of course, was true in the winter moth case which I previously outlined. There were 63 known parasites of the winter moth. The study investigated each of these and chose six as having a high probability of success.

How do we measure the benefits of such a study? Let's look at the situation with and without the study. The difference between these two situations is the benefit. Let's assume that the total savings that could be achieved with immediate adequate control was 10 million dollars. Without the study, we could probably go through the 63 parasites and pick 10 that look promising just on intuition. If we estimated the probability of success the picture might look like this:

Benefit	Probability	Net Worth
10,000,000	30	3,000,000
5,000,000	50	2,500,000
1,000,000	13	130,000
- 1,000,000	6	- 60,000
-20,000,000	1	- 200,000
		$5,370,000

These figures assume a 30 percent chance of total success, a 50 percent change of half success, 13 percent chance of sum success of some success, a 6 percent chance of some loss and a 1 percent chance of an ecological disaster. The total net worth of this course of action if $5,370,000.

With the study we would delay action for one year and let's assume that total benefits which could be achieved with adequate control in one year were $8,000,000. Estimates of the probability of success table may be as follows:

Benefit	Probability of Success	Net Worth
8,000,000	50	4,000,000
4,000,000	30	1,200,000
1,000,000	20	200,000
		$ 5,400,000

In this set of figures we have eliminated any chance of loss and increase our chances of total success. The net worth of this alternative is $5,400,000. The benefit of this study, under these

hypothesized circumstances would be $30,000 assuming that the control programs were identical in cost. If the study cost $25,000, which really doesn't buy a hell of a lot at today's prices, the benefit/cost ratio would be 30/25 or 1.2 to 1.

The case I have worked out here is purely hypothetical but the relative magnitude of the values are in the ball park.

Every once in a while someone comes in and says, "Why can't you recommend this program? When I figured the benefit/cost ratio it was more than 5,000 to 1." I feel the same way that Paul Flink, my Michigan Entomologist friend did when a little old lady wrote and asked "if moths are attracted by light, why don't they all die flying to the moon?" People with benefit/cost ratios of 5,000 to 1 usually don't understand the basic concepts of the tool they are using.

MINUTES OF FINAL BUSINESS MEETING
March 9, 1972

The meeting was opened by Chairman David Wood at 10:20 a.m. The leaders of the group discussion sections on the future of the Work Conference reported. In general all the discussion groups agreed that the conference should continue in its present form.

The location for the 1974 meeting was discussed. Walt Cole spoke in favor of the Salt Lake City area and moved that the meeting be held there in 1974. The motion was seconded by Boyd Wickman and passed on a vote of the membership.

It was moved by Ron Stark, seconded by Pat Shea, that a committee be appointed to investigate the possibility of meeting jointly with the Western International Disease Work Conference in 1973 and 1974--passed by majority vote. Chairman David Wood appointed Stu Whitney and Roy Shepherd to serve as the committee.

C. J. DeMars reported for the nominating committee. The candidates recommended were: Bob Stevens for Chairman, Mel McKnight for Secretary-Treasurer, and Bill Ives for Councilor.

C. J. DeMars moved the slate of candidates be elected. The motion was seconded by John Schenk. R. C. Hall offered an amendment to the effect that a unanimous ballot be cast in favor of the slate of candidates--passed on vote of the membership.

Alan Berryman suggested that a grant be made by the Council to reproduce the references compiled by Bob Furniss for the revision of Insect Enemies of Western Forests.

Roy Shepherd moved that the Western Forest Insect Work Conference express our appreciation to Bob Furniss for the excellent work he is doing in his revision of Insect Enemies of Western Forests and pass on the best wishes of the members for its early completion; and further moved that the Western Forest Insect Work Conference appoint a committee of one to explore the nature of the bibliography prepared by Mr. Furniss in the course of the revision to determine the feasibility of publishing or otherwise making the bibliography available to forest entomologists. The motion was seconded by Ralph Hall and passed on a vote of the members.

Red McComb reported that Bill Wilford was selected to replace Les McMullin on the common names committee.

Treasurer Tom Koerber reported that although all the bills for the meeting had not come in as yet, it appeared we would make a small profit on the meeting. Registration figures show 71 full members and 11 students attended the meeting, and an additional 9 persons registered for single sessions.

Chairman David Wood offered thanks on behalf of the membership to the local personnel who worked to make the meeting possible.

There being no further business, the meeting was ajourned at 11:15 a.m.

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